TREATISE UPON

CHOLERA INFANTUM,

CONTRASTED WITH OTHER ALLIED DISORDERS.

Being a Thesis for the Degree of M.D. of Edinburgh University.

by

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C O N T E N T S.

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Chapter I.

H I S T O R Y .

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Starting from the earliest days of Greek medicine long before the time of Hippocrates and culling from the time when Homer wrote or when the temple at Jerusalem was dedicated, we find allusions to medical science. Aesculapius, the father of Greek medicine, 1142 B.C., lived 50 years before the Trojan war and his two sons were the earliest examples of the army surgeon. Under Agamemnon Machaon is described in the Iliad XI. as a wise physician, "skilled our wounds to heal and more than armies to the public weal." It is not surprising to find Homer drawing a picture of these physicians restricting themselves to healing the wounds of the heroes. It would have been somewhat incongruous for the poet to sing of sick heroes drinking the nauseating mixtures of physicians. Daromberg says, "Les heros ne prennent pas le temps d'attendre une fluxion de poitrine ou d'avoir le colique." We find Pliny (23-79A.D.)restricting Homeric medicine to the treatment of wounds (Chap. 29) Doubtless there were outbreaks of diarrhoea of a choleraiform type in armies even in the battle fields before the Ilion. Both Democritus and Hippocrates, however, the first systematic writers and crystalisers of ancient clinical knowledge

refer/

refer to these forms of diarrhoea although, of course, not under modern names*. There is a form mentioned by Hippocrates called Cholera sicca, in which milk was believed to be anodyne, and some forms of painful dysentery are described which are only amenable to an exclusive milk diet. Hippocrates employed eggs to cure a form of diarrhoea which doubtless was analogous with Cholera Morbus or with Infantile Diarrhoea.**

On examining the Hippocratic aphorisms one finds many allusions to bowel complaints under the various terms of:

(a) "Spleneticks" (Aphor.VI. 43) Persons who are affected with dysentery die of dropsy or lientery. The translator describes this as slipperiness of the guts.

(b) "Iliack Passion"(Aphor.VI., 44) Succeeding strangury unless within seven days unless plenty of urine issue forth upon the supervening fever.

(c) "Dysenteria"(Aphor.VII., 76) After the bloody flux comes lientery and immediately the stomach and intestines have lost their tone.

These diseases seem to have been commoner in Autumn than in the hot months at this time (III. 22) "In Autumn there are many diseases including Iliack passion." Hippocrates notes (Aphor.VII., 26)

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* De Victus ratione in acutis, p.396.
" " " " " p.405.

** Ibid.

"That great coldness and chills after vehement pain in the belly is bad and that purging of the bowels (IV.66 convulsions vehement pains about the bowels in acute fevers are bad."

It must not be thought that the Greeks were the only ancient nation who had a complete medical system. Many papyri, recently brought to light, have shown the scientific tendency of the Egyptian mind, and the Papyrus Ebers, the most recent and complete, gives a description of the diseases then treated and what the remedies were with which these ancient Egyptians about the time of Pharaoh used to treat their sick.*

The belly and the spine were assimilated to Sechet. Diseases of the abdomen received a large share of attention. They treated indigestion, or over-loading, as they called it, with onion water or sweet beer which was supposed to check vomiting. For diarrhoea they mixed onions with milk, especially cow's milk after it had been boiled; sour milk, oil and beer with certain plants in it were frequently taken for indigestion and diarrhoea, and they had numerous unguents for external application, a form of treatment which any practitioner can see at the present day among the lower order of Jews. The blood of the pigeon, the goose, the swallow and the eagle prepared in a dry form, was administered internally as a styptic and intestinal astringent,

* "Book of the Dead", Facsimile of the Papy. of Ani in the British Museum.

a form of treatment which has recently been revived slightly modified.

Very little can be said of the Chinese medicine, except that they derived most of it probably from the Egyptians and that it has probably not advanced during the last 4000 years. This view is endorsed by Bryant in his "New System of Ancient Mythology" Vol.IV., p.256, and by Sir William Jones' "Dissertation on the Gods of Greece, Italy and India." Blood is used in China for checking diarrhoea. The butcher sends to market blood dried, having separated the serum from the clot, and the blood of the mountain goat is regarded as a specific against flux of the belly. For the debility which follows prolonged diarrhoea they evaporate the urine of children, mix the residue with lime and salt and administer that. Milk is given in diarrhoea and in convalescence from chronic catarrh. The external lining of the gizzard of some animals was extracted and prepared for administration, in the diarrhoea of children care being taken to take the gizzard of a cock for a female and of a hen for a male. This prescription is nearly analogous to the Pelliculae Stomachi Gallae Interiores of the London Pharmacopoeia (See Salmond's translation). One cannot fail to observe the connection between all these systems of medicine and probably they have

all been derived from the Egyptian. Roman physicians undoubtedly got their medical system from Greece. The story of the Embassy of Greece and of the Epidaurian magnanimity is told by Ovid and is familiar to everyone (Valerius Maximus, Book I., Ch.VIII, Article 2.)

Pliny, who may be taken to embody the medical knowledge of the Romans, describes, in the language of Holland, his translator, the troubles connected with the management of the abdomen thus, "Touching the paunch or belly much adoe there is with it, and although most men care for nothing else in this life, but to content and please the belly, yet of all the parts it putteth them to the most trouble. For one, while it is costive, as that it will give no passage to the meat, another while was slipperie as it will keep none of it. One time you shall have it so peevish as that it can receive no food and another time so weak and feeble that it is able to make no concoction of it." He notes the use of the inner coating of the gizzard of the hen as being "singular for the catthars that fall into the breast" (stomach). For colic he says there is nothing so good as to take three spoonfuls of burnt larks, feathers and all, in the drink. (p.383) Ashes of calcined stomach of the inside lining of the gizzard

with a little opium were considered to be of great power as a remedy for abdominal disturbances.

In Celsus and Galen the same kind of description and treatment of fluxes and dysenteries are to be met with and many similar kinds of references could be given from their works. These again were in turn perpetuated by the Jewish Masters in the schools of Bagdad, Cairo, Heliopolis, Kufa, Borsippa, Bassora and Arbela, the great schools through which the torch of science was handed to the Arabians who with a tremendous force of intellect overwhelmed the world up to the 11th century from Cordova to Bagdad. Aetius, Aaron-Ahran, Mesue, Honein (Hunain i. Ishak) Sabor ibu Sabel, from 550 to about the end of the 9th century left things pretty much as they were, but Rhazes, by his vigorous and accurate descriptions of disease (832 A.D. to 923 A.D.) at once lifted Arab medicine on to a pinnacle of fame and imparted to it an importance which scarcely any other epoch can surpass. Rhazes was a native of Ray in Northern Persia, the Rages of Media. The Arabs had laid under tribute all systems of medicine, Greek, Indian and Italian, and translated the literature into the Arabic tongue. Rhazes (Thos. Stack's translation, 1748) has written a chapter "On managing discharges in smallpox" which will

readily obtain the appreciation of the most modern scientist. He says, "Now, if the belly be lax give nothing laxative for anything that increases the discharge is not safe in either of the distempers. Order the patient to drink barley gruel boiled in pomegranate seeds. If this is not sufficient give Gum-Arabic and sugar. In continued looseness give draughts of Al-raib, i.e. sour milk with some biscuit and a little Gum-arabic."

A treatise also exists from his pen which sets forth accurately the medical knowledge regarding Infantile Diarrhoea during his period and which shows that in the main the condition was practically the same as it is now. We give the following exact translation of this important section of his work on children's diseases:- "De aegritudinis puerorum et earum cura, qui appellalur practica puerorum."

> "Very often the bowels of children become loose in dentition as we have said, or when the child is bound up by cold or by the corruption of the milk from bilious humours (colera) orphlegmatous humors (phlegmate). And the sign of the choler is found in the stools which are acrid and sharp. It dies without delay. The sign of cold and phlegm is whiteness in the stool and gripes (tortio in ventre) and unless the phlegm be viscous it dies directly.
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> "The cure is to give the child Syrup of Roses or Macianorum? or pomegranates with mint and take spodium (the ashes of vegetable matters) put in water and drink. Or take yeast dissolved in water and filtered (cola) and take the sixth part, three parts vegetable ashes, three parts of gall, five of saffron, give as a draught. Ano-

"ther recipe is the seeds of sorrel, violets and mix with the white of egg and give it to the child to drink. Or give him this medicine. Take the sorrel seeds, dried and burnt, acorns and the seeds of white poppy of each three ounces. Saffron, make into four powders and give it to the child with syrup of citrons or of roses. Put a styptic plaster on the stomach. Take a decoction of summac and treacle and wheat flour or of millet and put it on, and if the flux is checked, good. But if not take accacia and white lead of each one drachm and make a plaster lint and lay it on. The flux will immediately cease. But if it arises from cold or phlegm give the child one-eighth part of a drachm Gallic (gall) nuts with the juice of Syrian figs or take the fourth part of Oribaum make a plaster it is good for loose bowels. Take saffron, myrrh, make it up with wine and apply it.

From the time of Rhazes one may pass over the views of Isaac, the Jew, Avicenna, Avenzoar, Simeon Seth and Serapion as representing simply disquisitions and explanations of Rhazes' works.

The views held by our more immediate Saxon ancestors, if indeed we can find anything bearing on the general question of the treatment of diarrhoea in infants up to 679 A.D. show them to have been altogether dependent for their knowledge upon compilations of Pliny made by Sextus Pracitus and Marcellus. The Saxon leeches were too rude to learn much from Galen. Demonology, charm cures, faith cures and priest cures carried all before them. They could only treat symptoms such as "sour of the milt", "waxen kernels", "weals and flecks", "foot

addle", "drowsiness", "over-sleeping", "pain in the bladder", "sore eyes", "pain of the wamb" or "wame adle", this last being commonly associated with children may be taken to represent our modern infantile diarrhoea. The Saxons treated it with "heels of the hare" carried on their coats, and the boar was a kind of "All-heal". "For every sore a boar's brain sodden and wrought to a drink in wine alleviateth all the sore." The wild boar's liver boiled in wine was an astringent in these cases (See Sextus Placitus). The goat's head boiled and pounded up was administered in cases of diarrhoea. The change from this kind of ignorant retrogression came gradually more than a century after the revival of learning. The first authoritative pharmacopoeia was compiled in 1498. Signs of advance then became visible. Anatomy had been introduced into Germany in the reign of Frederick I., and De Mondeville had dissected bodies in Paris. In 1543 Vesalius Work on Anatomy removed the thick veil of ignorance which over-spread medical science, and schools commenced in this country as in the case of the Royal College of Surgeons of Edinburgh in the year 1505 to ordain that "Every man was to be examit and previt in the poynts floowing, that is to say that he knaw anatomea. For every man aucht to

knaw the substance of everything that he wirkes." This naturally led to progress and the fruit embodied in the works of Willis and Sydenham (1624-1767) who have left us the most accurate description of disease since the time of Rhazes and made some very important advances in the method of treatment.

Sydenham says regarding cholera morbus or infantile diarrhoea, that it appears at any time of the year and originates in gluttony or over-drinking. He says there is a sort of cholera morbus exceedingly fatal to infants. It arises either from over-feeding or from teething. Here their tender age forbids the use of free dilutent drinks and still more the disturbance of the humors that would be effected by cathersis. Hence the cure must be attempted by laudanum alone, i.e. with 2, 3, 4 or more drops according to the age of the child taken out of a teaspoonful of small beer or some other proper liquor and repeated as the case requires. He gives them diluent drinks but not so freely consisting principally of broth made of tender chicken.

In his treatment for bilious colic he says: "If the disease have arisen from the over free use of the fruits of the season or from any other imprudence in food, the stomach must be washed out at

once by a large draught of milk and beer. (Compare with Egyptian treatment, page). After this an anodyne must be given. The next day a vein must be opened." If the patient is almost worn out with bad treatment, he prescribes plague water (aqua mirabilis) or some similar drink.*

It was Willis, the great anatomist (1621-1675) who first dreamt that this trouble was caused by an acid ferment in the stomach, and Nehemiah Grew noticed the existence of the glands in the mucous membrane of the stomach and spoke of animal ferments perfecting the work of digestion. The Italians, Redi and Borelli, held a purely mechanical theory of digestion, and many English Physicians, among whom was Pitcairn, Professor at Peiden (1652-1713). Pitcairn was a devoted adherent of Borelli's view which had been formulated originally by Aristotle's nephew. In the new London Dispensary in the year 1678, it is stated that the stomach of the partridge, powdered and drunk in black wine was helpful for the Illiac passion. (Compare with Pliny's treatment in the first century). It appears that these methods of treatment were derived merely from purely clinical observation before the idea of fermentation

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*Sydenham's Works, 1850, Vol.II. (Greenhill's Edit.)

had entered the minds of Van Helmont or of Sylvius or of modern investigators, but improvement was very slow. Men had to contend against the "whyms of Chymysts" and the fanaticism of occult qualities, but it was a sign of medical progress when a Sir John Floyer openly held in regard to medical science, that "it was no dishonour to a philosopher to change his opinions every day as often as he found cause for doing so."

How slow progress was cannot be better illustrated than by quoting from the works of an English practitioner in physic in the latter part of the 17th century. The extract from this work gives a view of the humoral pathology, symptoms and treatment of infantile diarrhoea at that time. The writer says that "It is caused by bad concoction or corruption of the milk or nourishment. By unnatural heat digestion is hurt. The heat of the fever doth stir up many humours which flowing to the belly causes these fluxes. They suck or drink more than is meet. Also the nurse doth often offer it the breasts." He summarises the causes under four headings:-

I. Attraction of the humours and their falling down into the stomach.

II. The teeth and gums are made soft and temperate.

III. Moist children. "There cannot be so much heat as to produce so much acrimony and saltness."

IV. If the humours were salt and sharp they would soon breed ulcers of the mouth.

He further says, "Or it may arise from bad nourishment or from badness of the milk from whence corrupt juice (sic) is bred in the stomach which nature expels by stool, or it may come from sharp humours in the stomach."

"If it comes from hot humours and corrupt nourishment then the excrements are yellow or green also stinking and the pains of the belly are greater." It appears that he had observed the fact that fever sometimes arises from decomposition of the milk albumen which causes the greenness of the stools and in which many bacteria have been discovered by recent investigators and alleged as its cause.

He treats the nurse, looks to the milk and administers syrup of roses. One of his most important treatments is to give the "yolk of an egg" (cf. with Hippocrates) roasted at the fire mixed with many carminative seeds, syrup of quinceys, nut meg and mastick, acorn cups, sorrel seeds, kernels of raisins made into a powder and combined with a half dram. of white poppy. He also uses external applications, ointments, wine baths, and bread plasters on the abdomen. "Some," he says, "recommend

the maw of a kid or hare," reverting here to very ancient treatment. "If ten grs. thereof be given and the child to take no milk that day lest it curdle in the stomach, feed it on milk sop, rose water and sugar."*

The treatment, as has already been noticed, of administering laudanum was not confined to Sydenham. We find Francis de la Boe Sylvius, who about the 17th century created at Leiden a school of medical chemists, in a work entitled "Of Children's diseases given in a Familiar Style for Weaker Capacities," (1682) attributing this disease to flatulence and acid humours. In treating the disease, he seems to put great stress on "such things as gently make drowsy and stupify," such as syrup of white poppies and a little laudanum. He says, "If the pain be very great you may safely add one grain of laudanum to three or four of the mixture and give to the child a little spoonful often till his pain and crying abate and he take rest."

He maintains that "Sour humour" takes its origin in the sweet bread, and refers to Infantile Diarrhoea under the name of "A Green Purging with Sour Savour". It is accompanied with gripes," and as he says, "this noted green purging proceeds from choler and such like changes of colours are not unknown to

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* Robert Pemell, Practitioner in Physick, Cranebrook, Kent, May 29th, 1653.

dyers." He is concerned to find out why gripes do not constantly accompany this disease and attributes the immunity from pain in those cases to the circumstance that "the guts are plaistered in the inside with rough phlegm and therefore the sour humour cannot fret and bite them."

Although professor of materia medica in the University of Leiden, his specific cure for this trouble is the bezoar stone, preferring the oriental to the occidental and the mineral bezoar he considered much better than either, whether it be made of antimony or silver or gold. A clyster was prescribed made up of cow's milk, yellow of egg and Venice turpentine.

Perhaps it is not too sudden a leap to turn from the effete humoral theory to the views which came into existence with the "Cellular pathology". Although the intervening period was one of considerable investigating force and medical science was beginning at this time to emerge from pathological ignorance. The humoral theory of the Arab Physicians, successors of the Greeks, was by Paracelsus combined with the fantastic idea of the Orientals into the "Archaeus" or the force of life. It was the search for the "life force" that was responsible for nearly all pathological progress and in the

*Dr Franciscus de la Boe Sylvius "Of Childrens Diseases given in a Familiar Style for Weaker Capacities." By: R.G.Physician, (1682)

"Archaeus" one catches the first glimpse of the modern theories regarding the origins of life and the germ from which future disease knowledge sprung forth. It was the Leiden school under Boerhaave, Bernard Albinus and Gaubius who laboured most closely at this subject, to which the cope stone was put by Haller. His doctrine of animal motion being dependent upon "Muscular irritability" was a step in the direction of the discovery of the living cell which has made modern progress possible.*

In spite of many difficulties pathological science by the help of the microscope has demonstrated the facts known as the cell theory of pathology which led Virchow to formulate a new dogma of medicine, "Omnis Cellula e Cellula", and which showed that even diseases life produced new cells from which types and ancestors were not forthcoming in normal life and which proved ultimately that the cell was not only the seat and vehicle of disease, but the seat and carrier of individual life and of individual death. Descriptions of disease from henceforth do not solely aim at recording symptoms, but at investigating it in the new sense as Morgagni first applied in his work called "De Sedibus et

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* Virchow's criticism on Haller's statements, found in Haller's work, entitled "De partibus corporis sentientibus et Irritabilibus." (oper. Min. Laus. 1762, Tome 1, p.407) Archiv. fur Path. Anatom. und Phys., Vol.XIV., p.1 (1858).

Causis Morborum", to which we shall have occasion to allude further, which called into life a new science of pathological anatomy. At the beginning of the present century therefore we find perhaps the only complete account of infantile diarrhoea which it has been hitherto possible to give through the course of the ages, during which from the time of Hippocrates till now the connection between the history of Medicine and the history of mankind have been continuously connected.

This disease has only within the last 100 years received the name of infantile diarrhoea. Prior to this it had been described by all sorts of names, "Flux", "Cholericlask", "Softening of the Belly", "Iliac Passion", "Diarrhoea of Children", and "Cholera Morbus". In some of the mortality bills of London deaths from this cause are included under the title "Griping of the Guts", subsequently confounded with Infant Convulsions. In Scotland it has been called"Wame Ill", and the "Belly Hives". In Germany it has received the names "Kinder Cholera" and "Acuten Brechdurchfall".*

In France "Cholerine" (Arch. Gen. Medicine, Paris), "Choleriform Diarrhoea" (Duchesne, H., Congress of Paris, 1863, Vol.I., pp.324-327.) In

* Prag. Med. Wochenschrift, 1881, VI., pp.322-336.

America it has been called "Bilious Diarrhoea" of Infants (Miller, E., Med.Reposit., N.Y., 1798, I., 58-65, 1800.) Second Edition I., 63-72, also his medical works, N.Y. 1818, pp.375-392. "Summer Diarrhoea", "Autumn Diarrhoea", and in the Southern States, "Disease of the Season", "Summer Complaint", "April and May Disease".

The first enquiry into the cause and cure of this disease under its modern name of "Cholera Infantum" was written by Benjamin Rush*, Professor of Chemistry in the University of Pennsylvania, in the year 1773. By this name, "Cholera Infantum" he says, "I mean to assignate a disease called in Philadelphia, the vomiting and purging of children. From the regularity of its appearance in the summer months, it is likewise known by the name of the "Disease of the Season". It is distinguished in Charlestown in South Carolina by the name of the "April and May Disease", from making its first appearance in those two months. It seldom appears in Philadelphia till the middle of June or the beginning of July and generally continues till near the middle of September."

Dr Rush observes that its frequency and danger are always in proportion to the heat of the weather

* Rush, B., "Medical Inquiries and Observations", 1773.

and that it affects children from the first or second week of birth till they are two years old. He describes the symptoms and says, "this disease has been ascribed to several causes, of each of which I shall take notice in order." Then he mentions dentition which he puts aside by remarking that the disease appears in one season of the year, but acknowledges that most children die of this disease about the tenth month.

(2). Worms. He objects to worms being suspected as the cause of this disease because of the annual epidemic nature of the disease, because it resists anthelmintic medicines, and lastly on the grounds that no worms have ever been discovered at a post mortem examination.

(3). Summer Fruits. He objects to this being classified as a cause of Infantile Diarrhoea in as much as it is not known in the country where children eat most fruit. He is disposed to consider it a modification of Cholera and Remitting Fever from the time of its appearance.

He devotes two pages to mentioning the remedies.

(1) Evacuate the belly and stomach by tartar emetic and ipecacuana.

(2) Where the purging is too violent he uses a few drops of Laudanum, peppermint and cinnamon water.

(3) Demulcent and diluent drinks.

(4) Glysters of Flaxseed tea.

(5) Plasters of Venice Treacle.

(6) Cordial Medicines.

He observes the use of the warm bath in cases of obstinate pain and adds that the bath is more effectual if warm wine is used instead of water. (cf. with the whisky bath of Scotland.)

Regarding the prophylactic treatment:

(1) He recommends the use of the cold bath daily.

(2) Attention to the clothing of children.

(3) Recommends a moderate amount of salted meat to be given to children in those months in which the disease prevails because country children who eat salt beef escape.

(4) The use of sound old wine in the summer months, a teaspoonful to half a wine glassful every day, because children who sip the dregs of the wine that their mothers have been drinking are much less subject to this disease than the children of poor people.

(5) Cleanliness.

(6) Removal of children to the country.

Researchers, however, will look in vain for a more complete clinical picture of the disease of Infantile Cholera than that given by the graceful Trousseau in his "Medical Clinics". *

In Trousseau's description he observes that hitherto no single name has been in any way expressive of the character of this disease and he ex-

* Clinique medicale de l'Hotel Dieu de Paris, Tome 3.

explains that he uses the term Infantile Cholera or Cholera Infantum because the name had been consecrated by usage and that he was an enemy to all new nomenclature.

Since Trousseau's time there is little to record that can be regarded as a history of the disease except some investigations which have been suggested by progress which have been made in a new direction in pathological science, that is to say in the direction of bacteriological and physiological chemistry. But these are subjects which have so complex a bearing upon other departments of investigation into this subject that it may be well to defer the consideration of the history of modern research to a more suitable place.

CHAPTER II.

EPIDEMICITY AND GEOGRAPHICAL DISTRIBUTION.

EPIDEMICITY AND GEOGRAPHICAL DISTRIBUTION.

The epidemicity of this disease has been long since established and has exercised the attention of investigators both in this country and abroad. Associations have been appointed for the purpose of investigating the etiology of infantile diarrhoea, especially among Medical Officers of Health. Government investigations have also been organised and many independent opinions expressed on this subject by those who have acted as medical officers of clubs or friendly societies and whose labours have been chiefly devoted to the interests of the poorer classes of the population. From the time of Sydenham successive practitioners and medical officers have enquired into and reported upon the nature of this disease and how far it might be presumed to assume an epidemic character.

This disease has been recently believed to be a result or product of industrial town life, and at all events, since the registration of deaths was instituted in 1837, comparatively recent history has little light to throw on its etiological history. Still less can be found in the records of remote history. The search for light on the subject of Infantile Diarrhoea is still more complicated by

the diversity and uncertainity of the nomenclature of the earlier centuries, and by the meagreness of the records about a specific form of disease so generally classed among "Diarrhoeas". The vigor of the treatment for "Fluxes" or "slipperiness of the Guts" by ancient physicians shows how common it was and how it was dreaded. Rhazes describes the looseness of children as occuring "very often" and its virulence by saying that in certain cases the child "dies without delay". Sydenham remarks that it is "exceedingly fatal to children" and Willis, a contemporary of Sydenham, descants on its "seasonal recurrence". Morgagni, in his "De sedibus et Causis Morborum" observes that the autumnal season seemed to be most prolific. "For the same time (Morg. Vol.II., Bk. III, letter XXXI., Art.9, page 73.)the same year, "the same city, London had intestinal fluxes spread-"ing through it 'epidemically', without blood, in-"deed, but attended with 'griping tortures'." Yet so different were the disorders that Willis differs from Sydenham in his description of the character of the disease - the one describing a "watery flux" the other a "mucous flux". This difference is accounted for by Morgagni as arising from "the different parts of the city, altho there might be the same kind of irritation in the intestine of all."
This view has also been endorses by Creighton

(Epidemics in Britain). Willis lived in Newgate Street and had his practice round Cripplegate, Shoreditch, Spitalfields, Whitechapel, St.Olaves, Southwark, Lambeth, where the largest Bills of Mortality came from, while Sydenham lived in the West End (Pall Mall) and saw perhaps a different aspect of the disease.

An attempt has been made by some chroniclers to connect these diseases with times of hardship as in the Chronicles of St. Albans by Trokelome in 1315-16, who refers to a disease which he describes in the phrase "Morbus enim dysentericus ex corruptis cibis fere omnes maculavit." (For Dysentery from corrupted food has affected nearly everybody.) Dysentery was a term which in those days denoted Infantile Diarrhoea as well.* It is recognised even now to be synonymous with Cholera Morbus, the only distinction in the case of young infants being its fatality.

Sydenham observed that the "Bilious Colic of 1670 & 1672 attacked mostly "the young of a hot and bilious temperature and was most rife during the hot season" and was in his time so** fatal that "many thousands were perishing."***

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* Sydenham's Observations on the Dysentery of London, 1669. Greenhills Edit. p.160-169.

** Observ.Med. IV. c.7, Sect.2.

*** Observ. Med. III., c.2, Sect.54.

Willis mentions "Convulsions" as being due to "Fits of the Mother", and as occurring one month from birth and during teething, and attributed them to "Worms" or "Sharp humours", a term which was constantly employed to describe the etiology of Infantile Diarrhoea. The influx of infants proceeding from a mixture of Humours falling down into the Intestines or from a swelling of bile with an acid which is in great abundance in that place.*

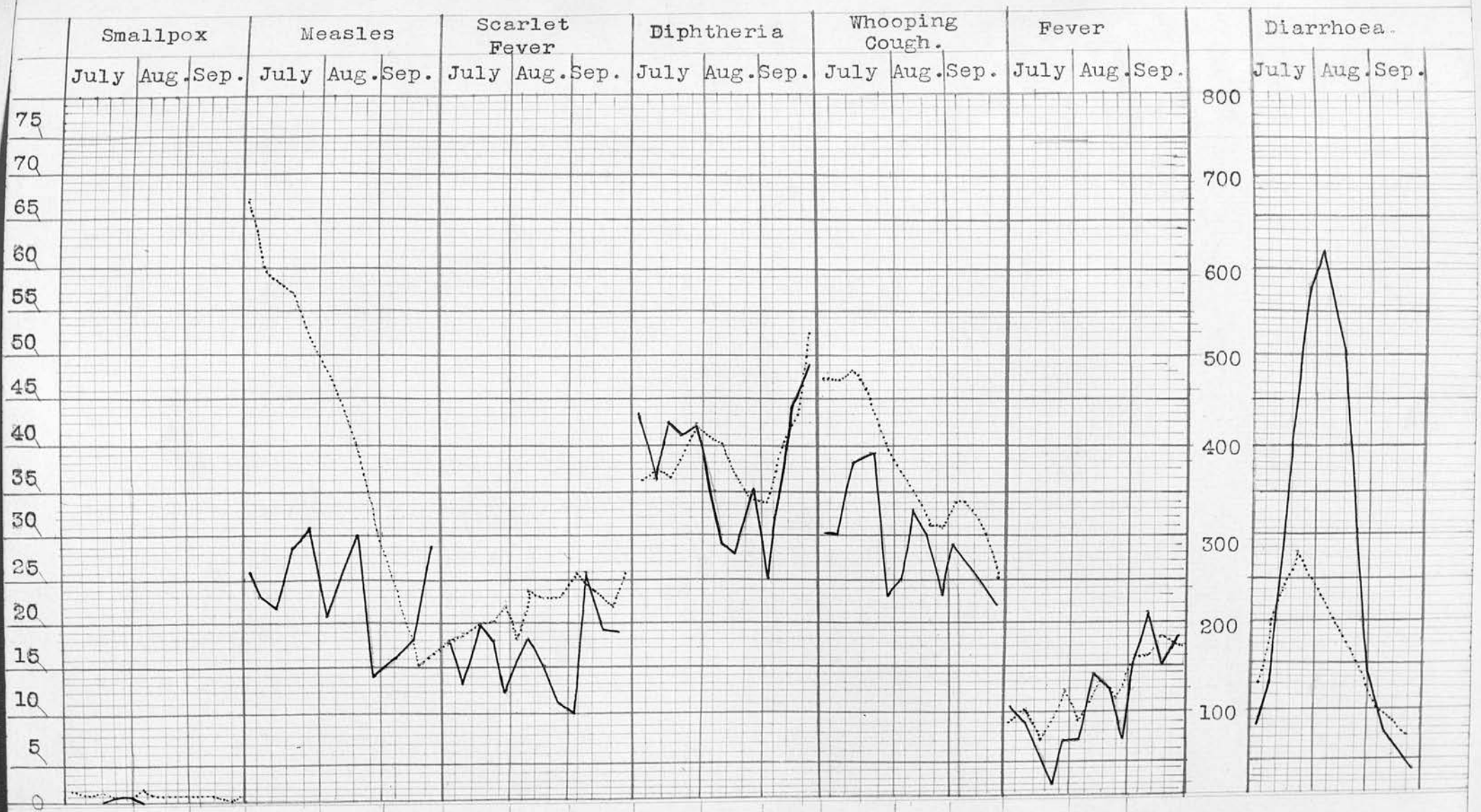
It was apparent that London was visited with greater frequency and with greater intensity by this disease up at least to the end of the 17th century. The largest bills of mortality came from the densely peopled parts of that city. The disease was classified in these bills as "Griping of the Guts".

Writers in the early 17th century had already learned to recognise the condition named "Epidemic gripes" occurring between the middle of July and the middle of September,** and attributed it to "the natural heat exhausting the strength of the children." Harris set down the virulity of the trouble as "causing more deaths in one month than any other three that are gentle." In 1669 the weekly mortality in London from "Griping of the Guts" during

* Willis - Pathol. Cerebri. Pordage's trans. p.25
Harris (W). Diseases of Children, p.96.

** Harris (W.) Tractatus de Morbus acutis infantum 1689.

DEATHS FROM ZYMOTIC DISEASES IN LONDON DURING THE THIRD QUARTER OF 1897.



Note: The black lines show the recorded number of deaths from each disease during each week of the quarter. The dotted lines show the average number of deaths in the corresponding week of the ten preceding years, 1887-96.

the last two weeks of the months of August and the first two of September were given at 182, 269, 318, 277, gradually tapering off to 89 in the first week of November. In 1670 statistics of the same nature can be produced.*

The same peculiarities and characteristics can be shewn to be maintained at present from the Report of the Metropolitan Asylums Board.**

The death rate appears to rise in August and fall in October. Thus the month of the greatest prevalence, say in Manchester for

1878	was	August	)
79	"	September	)
80	"	August	)
81	"	July	)
82	"	August	) Ballard's Report,
83	"	August	) p.35.
84	"	Sept. & Aug.	)
85	"	August	)
86	"	September	)
87	"	August	)

The numbers seem to bear a ratio to the density of the population, thus in 1671 showed a death rate of 238 from diarrhoea out of 607 deaths.*** The population of London was less than 500,000. From 1681 to 1891 the population increased from 500,000 to 5,000,000.

The most fatal summers to London infants were

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* Creighton, Epidemics in Britain, Vol.II. p.750.

** See Metropolitan Asyl. Bd. Reports, 1896.

*** Creighton, Vol.II.

1669 when 4385 children died from "Griping in the Guts" and 1670 when there died 3690.

During the earlier part of the 18th century a change in "registration" seems to have occurred and "Convulsions", the generic term for the "Convulsive phenomenon" seemed to have been thought a better or more modern title for registration than the older fashioned "Griping of the Guts", although that term was at this time still used. If we take as examples the following years, we find:

	Griping of the Guts.	Convulsions.
1718. Sept.2.	28	265
1719. Sept.1	27	233
1723. Sept.3	23	308
1734 Sept.3	--	260

In regard to this Dr Ballard points out that "of all the cases only a small percentage run their course without convulsive phenomena of some kind." Out of 270 fatal cases only 17.8% were observed without these fits, termed "Infantile eclampsia," "Major Convulsions", "Workings", and "Inward Convulsions", which Dr Ballard takes to be "Laryngismus".

This circumstance would otherwise modify any deduction which might be drawn from the statistical records of the last century, regarding the Epidemicity of this disorder. Indeed, although the statistical records contain this anomaly of nomenclature

it would be somewhat premature to say that the appearance of the Registration Act of 1837 had cleared all anomalies of medical nomenclature before it. Indeed, the term "diarrhoea" which is now the authorised one, is quite as misleading for the purposes of this research as any that have hitherto been in use, and requires a special paragraph to explain its synonyms. This we take from the report of the prolonged investigation into this subject by Dr Ballard, who says, in reference to the registration of these deaths:-

"The most frequently used term is "diarrhoea". This term designates a complex malady by the name of its leading symptoms. Other terms, however, are in use, 'Choleraic Diarrhoea', 'English Cholera', 'Cholera nostras', 'Infantile cholera', are terms used sometimes to designate very severe cases which in one way or another appear to the persons using these terms as 'enteritis', 'muco-enteritis' and 'Gastro-enteritis' are employed, the person using them desiring to signify that he recognises in the illness an inflammatory condition of the digestive mucous tract.

When bloody stools or tenesmus occur, the disease is often designated 'dysentery' or 'dysenteric diarrhoea'. There is obviously a good deal of

fancy in the selection of any particular term as it is met with in public records, the terms 'diarrhoea', 'dysentery', 'dysenteric diarrhoea', 'cholera' and 'choleraic diarrhoea being those most commonly used in the diarrhoeal epidemic seasons, both in the case of infants and older persons; at other seasons the other terms are found to be more used, but still the term 'diarrhoea' predominates. Moreover, the term 'cholera' or 'choleraic diarrhoea' is applied less frequently to the severe malady of infants than when a similarly severe case occurs in older persons."*

Registration, however, brought to light a curious and hitherto unthought of point in the history of the epidemicity of this disease. The new statistics which in the first six months (July-December) seemed to place the saddle of the highest infantile mortality upon a horse of another colour. London had hitherto been the pis aller of statisticians, but the new figures seemed at first sight to place the burden upon the industrial population in densely populated manufacturing districts. From this time attention has been focussed upon these areas whenever it has been attempted to find causes or remedies for the excessive mortality of Infantile Diarrhoea.

* Report Loc. Gov. Board, 1889, Vol.XXXV. p.13.

The following table can be verified by reference to the first census and gives in order of the incidence of the infantile death rate.

	3rd Quarter.	4th Quarter.
Manchester	164	47
Liverpool	142	49
Leeds	52	37
Nottingham	43	4
Bolton	40	27
Newcastle	35	25
Stockport	28	23
Preston	21	20

When these figures are compared with some of the London figures the effect is startling.

Shoreditch	73	15
Greenwich	43	19
Kensington	35	13

The old terminology however must still have influenced the statistics for in the next year 1838, the "convulsions" come prominently forward. Deaths from

Diarrhoea,	Dysentery,	Cholera,	Gastritis, Enteritis	Convulsions
393	105	15	881	3419.

from which time the figures under convulsions gradually decline and those registered under diarrhoea correspondingly increase. Thus in 1847 the deaths from "diarrhoea" were 1976 and from "convulsions" 2258. At present they are nearly equally divided.

Be this as it may, however, the death rate from diarrhoea for England and Wales per million living seems to have risen to the enormous height of 900 between 1847 and 1850, and for London alone the rate was as high as 782. The last census showed a decrease 1881-1890 for the death rate from diarrhoea per million living, reduced itself to 662 for England and Wales while the rate for London alone somewhat exceeded the rate for England and Wales. It was as high as 749.

It is highly probable that this depends upon the kind of weather. The years of highest mortality were

In 1893	.....	28755 deaths.
1884	.....	26412 "
1880	.....	30185 "
1868	.....	30929 "

In all of these the heat was excessive.

During the ten years 1871-1880 there seems to have been a notable decline, and this has been fully explained by Sir William Ogle in the census of that year in a letter addressed to the Registrar General. He says:

"The deaths from diarrhoea fell from an annual rate of 1076 per million to 935, showing an annual gain of 141 lives for each million persons living. But as the mortality from diarrhoea is more directly and manifestly affected by meteorological conditions

than that from any other zymotic disease, it may be questioned whether the decline was not due to a series of comparatively favourable summers in the one decennium as compared with the other, rather than to any sanitary measures that may have been adopted. In order to test this we must compare the summers of 1861-70 with those of 1871-80; and as the great bulk of fatal diarrhoea occurs in the interval between mid June and mid September, we may confine our comparison to that trimestrial period. Speaking generally, it appears from the returns of mortality in London that the diarrhoea becomes high when the mean weekly temperature rises to about 63°F. Now in the ten years 1861-70, there were altogether 317 days in the three summer months in which the mean temperature recorded at Greenwich was above 63°F., while in the next decennium the number of such days was 325. Adding together the excesses above 63°F. of the 317 days in the first decennium we have a total excess of 1153 degrees, while the total excess of the 325 hot days in the second decennium was 1178 degrees. Measured, therefore, in this somewhat rough manner, the two decennia were practically on an equality as regards such temperature as may be supposed to raise the mortality from diarrhoea, and such slight difference

as the figures indicate is against the unhealthiness in this respect of the latter decenium. We may, therefore, infer with much probability that the decline in the diarrhoeal mortality is 1871-80, as compared with 1861-70, was not due to a lucky succession of cooler summers, but to improvement in cleanliness and other sanitary conditions." (Cf. this with the last annual Report, which see on p.) For all England from 1881-90 there was another falling off from 917 to 662, and in 1890 the annual mortality per million persons living from diarrhoea and dysentery, was 606 and the annual mortality of infants under one year of age to a thousand births was 149. For London the figures in 1890 were 655 per million persons living and 163 per thousand of infants.*

That year the deaths amounted to 15,933 and were in the proportion of 595 to a million living. The proportion had been 452 in 1879, 546 in 1860, 558 in 1881, these being the years with the lowest mortality from diarrhoea, but excepting these three years the mortality was lower in 1883 than in any other year from 1847 inclusive. In each of these years mentioned as having low diarrhoea mortality, the mean temperature in the Summer Quarter was more or less below the average, and in 1883 the departure in this quarter from the average amounted to 0.8°Fahr.

* Mortality in Registration Districts of England & Wales during 1871-80, by William Ogle, Esq. M.D. 45th Annual Report, p.379. (1885)

I wished to compare these with the statistics derived from last census and with the more recent statistics of the Metropolitan Asylums Board and those of the Medical Officers of Health of the towns and districts where the incidence seems to be greatest. But the task at present seems impossible. I will add, however, that in 1889-90, the deaths from diarrhoeal affections numbered 17,837 or 620 per million living. This rate was somewhat below the average doubtlessly in consequence of the cold in July and August, in which months the temperature was 2.2°F. and 1.6°F. below the average. This includes cholera, diarrhoea, and dysentery.

Table of English towns with highest death rate from Infantile Diarrhoea.

	Pop.1881.	1871-1880 Deaths per 1000.	Pop.1891	1881-1890 Deaths per 1000.
Liverpool	552,508	33.57	517,951	
Manchester	462,303	31.46	505,343	
Manchester (1874-80)		32.16		
Preston	96,537	28.05	107,573	
Salford	176,235	27.65	198,136	
London	3,815,544		4,211,056	
Holbeck		26.64		
St.Giles	45,277	23.42	39,778	
Whitechapel		33.03		
Leicester	122,376	24.46	142,051	
Sheffield	284,508	27.41	324,243	
Blackburn	104,114	25.29	120,064	
Leeds	309,119	26.04	367,506	
Wigan	48,194	25.77	55.013	
Stoke-on-Trent	104,288	25.80	121,359	
Birmingham	400,774	25.82	429,171	
Stockport	59,553	24.73	70,253	
Nottingham	186,575	22.55	211,984	

	Pop.1881.	1871-1880 Deaths per 1000.	Pop.1891.	1881-1890 Deaths per 1000.
Bolton	186,575	24.34	115,002	
Yarmouth	37,151	22.94	36,982	
Hartlepool	48,613	22.49	66,667	
Hull	78,222	24.52	77,926	
Sculcoates	99,868	21.66	135,681	
Norwich	87,842	23.32	100,964	
Northampton	51,881	22.65	61,016	
Worcester	41,376	22.13	43,963	
Coventry	44,831	21.59	52,720	
Goole	19,550	21.39	24.380	
Newcastle	145,359		186,345	

The geographical distribution is not limited to any place, to any town, or country, where there is a sufficient population and where statistics can be obtained. This is best illustrated by taking the continent of America, where ever since the time of Dr Benjamin Rush, American physicians have vied with each other in describing epidemics in the localities in which they practised.

Nearly every American medical paper contains articles on the pathology, symptoms, causes and in many cases they relate wonderful examples of cures which have been attained by certain medicaments. From all these it appears that this form of diarrhoea is specially prevalent in all large towns of America, from Quebec to New Orleans, from the Atlantic to the Pacific. It has even been attempted in a rough way by many of the States to compare the death rate from Infantile Cholera with the annual general death rate

but the figures given are so often at variance and so frequently contradictory, that it is impossible to lay any special stress on them, especially when the figures are extracted from these journals. Thus, in Philadelphia, the mortality was reckoned at 2.6 per 1000 of the population. It is as high and sometimes even higher in Baltimore, Louisville, St Louis, Memphis, which has been called "the graveyard of children," *and many other large American cities. Dr King says regarding Californian cities that more children die of Infantile Cholera and Lobular pneumonia than from any other disease.**

Central America, Mexico, and South America present but little information on this subject, although it appears that according to statistics in the cities of these parts*** in the first year of childhood is Infantile Diarrhoea. It appears that in Barbadoes, and other tropical countries the mortality is not so great. We have no information regarding Asiatic countries and Africa. African statistics have not yet sufficiently developed themselves to be available for purposes of this research. Richardson speaks of the heavy mortality =*= that infantile diarrhoea causes in the Australian

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* Grant, Amer. Journ. of Med. Science, 1853. July, p.108.
** American Journal of Medical Science, 1853, April, p.390.
*** Rufz. Archiv. de Medicin. Nav., 1869, Juin. p.431.
=*= Edinburgh Medical Journal, March, 1869, p.802.

colony of Victoria, and Hall says it occurs to a greater or lesser extent every year at Hobart Town in Tasmania.*

In all European countries, the same thing may be said, as has already been said about America. Every Journal, Wochenschrift, Tidschrift, Zeitschrift, of every locality contains articles on the pathology, treatment and epidemicity of this disease and the result is to prove that the mortality is in no respect less, but in many cases much greater than that of the Western hemisphere. There are accounts also of its great frequency in St.Petersburg.**

That the disease is a frequent and dread visitor in Italy is beyond doubt.

The best Mortality Tables are those of Baginsky, Berlin, Siebert in New York, and Miller in Baltomore. There are famous figures known by the name of the Stockholm figures, giving the statistics for twelve years, and of 998 cases at Stockholm, which may be found in the Arch. fur Kinderheilkunde, XI., and the Rev. Mensuelle des Maladies de l'Enfance, 1888, p.467. They are quoted in Dr J. F. Goodhart's Book on Diseases of Children, in the chapter dealing with the disease, and place the infant mortality there at 73%.

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*Trans. Epidemiological Soc., 1805, II., p.83

** Doepp, Abhandl, Petersb. Aertze, V., p.333

Regarding the question of the communicability of diarrhoea, some cases have been reported on by Dr Bruce Low.*

In one case an infant of two isolated on a Yorkshire Moor took Diarrhoea. The following day the mother was seized by vomiting and diarrhoea, then a child of five, then the farmer and subsequently his two farm servants were taken ill the same way. The farmer's mother-in-law then arrived to help the sick family, became violently sick and purged within twenty-four hours after her arrival, and then the Doctor himself and his assistant. The house was a solitary one and could not be seen from the road which crossed the moor. The mother attributed the child's illness to a chill.

The second outbreak occurred in February, when 14 cases were reported in a row of six houses, the first case occurred in the second house. Those houses which shared back-yards and privies were attacked. No one became ill who had not used these privies. The origin of the outbreak was said to have been due to the foul condition of the privies. A deputation from the Sanitary authorities visited the place to inspect them. "Two of the deputation contented themselves with viewing the scene and standing afar off, but the third gentleman, courage-

* Loc. Gov. Board, 1889, Report XXXV.

ous and conscientious, went into the yards and privies and saw and felt their condition." He was seized that same night.

The third outbreak occurred in a remote valley and spread from this to a school where 40 children took the illness. All the children, no matter whether from a village, valley, moor, or mountain side, suffered in equal degree from this outbreak, the only circumstance in common to all the cases being attendance at the village school.

The fourth outbreak proves the importation of the infection. Pockley is a small village of twenty-seven houses containing a population of 121 persons, not likely to be contaminated by tramps or travellers. There was no enteric fever. One of the inhabitants visited Leeds, where British Cholera was prevalent. Two days afterwards a child was taken ill with severe vomiting and purging, so was the mother. The motions were very offensive. On returning to Pockley, the two elder children were seized. The two children attended a Methodist Sunday School, about twenty-one children being present, and one of these developed an attack that night. 60 cases followed, all of which could be clearly traced to exposure of diarrhoeal discharges.

Dr Bruce Low has drawn up a chart showing the

progress of the out-break from the first case to the sixty-second. He summarizes the chief features of this infective form of diarrhoea as -

1. Its short incubation. Careful enquiries showed that the average incubation period was from 10 to 12 hours.

2. Its sudden invasion. In many cases the person retired to rest feeling perfectly well, but was wakened from his sleep by the pain and sickness as well as by the feeling of impending purgation.

3. The leading symptoms were severe abdominal pains, vomiting and purging, followed by great exhaustion and often fainting (in adults).

4. The motions were at first dark (sometimes dark green or yellow) becoming afterwards quite light coloured. Occasionally the stools contained blood. They were remarkably foul and offensive in odour.

5. The usual duration of the disease was from two to four days, but it sometimes continued longer. In some cases it lasted two or more weeks, and after those cases there were often intermissions.

Chapter 3.

E T I O L O G Y.

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We have shewn that the term Cholera Infantum is comparatively modern, dating from 1773. We have further shown that the disease has manifested itself at all times under similar circumstances. Its geographical distribution, so far as is known, seems to be world wide, if we except the case of the Barbadoes which, on the authority of Jackson (Boston Medical & Surgical Journal, 1867, July) seems to be less afflicted with this disease than might have been expected from the temperature and moistness of its climate.

It is obvious, therefore, that this habitually fatal disease in children demands the most earnest and comprehensive study both in regard to its nature and its causation. In the average of years its mortality to children under five is as much as one-tenth part of all the causes put together,* and this as we have shown notwithstanding the sanitary improvements which have been made, not only in London but in provincial towns.

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* Sir Geo. Buchanan "Report of the Loc.Gov.Board" 1887.

From the time of Rhazes practitioners and writers on the subject have ascribed various causes for the onset and continuance of this disease. Rhazes held that it occurred "When the child has been bound up by colds or by the corruption of the milk from bilious humours or phlegmatous humours." Sydenham did not give up the humoural theory and held that it arose from hot humours and corrupt nourishment. Willis was the first to ascribe it to some chemical action which he called "Acid fermentation in the stomach." De la Boe Sylvius followed him by ascribing it to some "sour humour originating in the sweet bread."

The first glimpse of new theories of the causation of this disease are obtained from Morgagni's "Seats and Causes of Disease", (Vol.II., Book III., letter 31, Article 9.) He speaks of intestinal discharges free from blood as the "yellow, green, watery and others of this kind" as being destructive not only from the "pain", but also from the "quantity". And all these excretions generally owe their origin to some stimulus that irritates the intestines by what means or from what part soever it got down to them, for as we see that a great quantity of humours is discharged by means of medicine violently purgative, so we may suppose that from some stimulating

fluid 'which is generated within this canal' or sent down thither from the arteries the same thing must of course happen." He could not suppose that the symptoms could be caused by "Bile" merely. Willis (Pharmac.Ration. f3, c3.) had described diarrhoea "almost watery" attended by "Griping tortures" which overspread London in 1670 in which the discharge was so great and weakness so pronounced "that if an equal quantity of pure blood had been discharged it could not have produced equal weakness."* "Motion and irritation" he held could be propagated from the stomach to the intestines.

Its seasonal recurrence had also attracted his attention. He talks of its autumnal recurrence and says "For the same time (p. 73) the same year, the same city, London, had intestinal fluxes spreading through it epidemically without blood indeed, but attended with "griping tortures'."

Yet so different were these disorders that Willis and Sydenham differ in their description of it. The one describes "watery fluxes", the other "mucuous fluxes".

The difference may have occurred in different parts of the great city "altho' there might be the same kind of irritation in the intestines of all."

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* Carolus Piso "De Diarrhoea Serosa" (Observ. de pretervis, hacten morbis ab aqua ortis, sect.4, c.1.

The first idea that external heat was a factor in the causation of this disease seems to have arisen in America. We find it stated in Rush's work (see Ch.I., p.14) "that its frequency and danger are always in proportion to the heat of the weather." Prior to that time the disease had been variously ascribed by American practitioners as being caused by "worms", "summer fruits", and "dentition", each of which causes Dr Rush tersely disposes of. Dentition could not be a cause of a periodic illness. Worms had never been discovered at a post mortem examination, and children a year old living in towns were not likely to eat more fruit than children in the country of the same age. An American Homeopath describes the disease as "the lot of infancy in hot weather of all climes". Heat was henceforth the main theory and doubtless there was a great deal to support it. From whatever place statistics were available, heat was the constant observable factor. The general prevalence of this disease, and its highest mortality, occurred simultaneously with the hot periods of the year. Thus in Berlin in 1877-82, the total deaths amounted to 17,641, of which June had 14,418, July 6,226, August 2889, respectively. The thermometer came to be looked upon as an index for an outbreak of this

disease. Whenever the "summer level" was reached (62°F. to 66°F.) the outbreak occurred, and this view was endorsed by Dr Ogle who suggested that the death rate followed the "mean weekly" temperature, and that it became high as soon as that temperature reached 63°F.* This appears to be a very good index, for in many of the Southern States, this "summer level" is reached in spring time, and the disease comes to be known in Charlestown, for instance, as the "April and May Disease". Within certain limits, therefore, a definite relationship can be shown to exist between the high temperature and high death rate from Infantile Diarrhoea. This view, however, was not universally accepted. Robert Pemell, an old practitioner of 1653, referred it to the humours flowing to the belly causing the fluxes. These were started because "they suck or drink more than is meet." He thinks that it occurs most frequently in "moist children", and disposes of the heat argument by suggesting that there cannot be so much heat as to produce so much acrimony and saltness.

Dr Ballard investigated in 1880 the effect of heat as a causal agent, but came to the conclusion that mere heat was not a sufficient cause of the disease. His words are, "It is not the main cause of the diarrhoeal mortality, but is exerted indirectly."**

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* 45th Annual Report, Lond. 1885, p.XIII.

** Loc.Gov. XXXV. Report, 1889, p.2

Regarding the influence of earth's temperature as opposed to atmospheric, that appears to be little if at all apparent until the 4 foot earth thermometer has reached 56°F.

The weather has always been regarded as a factor. Cold brings the epidemic to an end, and a lowering of temperature diminishes the mortality. Moisture seems to prevent a number of deaths, probably because the evaporation tends to reduce the temperature.

No very definite statistics can be obtained to show the effect of climate on this disease, although some writers assure us that in tropical countries children are more or less immune from the disorder.

Sea level has been a factor. Stephanos says that this disease is disastrously prevalent on the low plains and islands in Greece, while it is seldom seen in the higher lands where the temperature is more moderate.

The influence of soil has received consideration from writers on this subject, especially Buck & Franklin.* On this point there has been considerable diversity of opinion. Some hold that wetness of the soil is an important factor, and others that the mortality seems to have some ratio to the highness or lowness of the sub-soil water of the district. Ballard thinks the influence of the

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* Medical Times & Gazette, 1876, Jan., p.94.

soil a decided one in some respects. A rocky soil with little superincumbent material lowers the diarrhoeal mortality. On the other hand, a loose soil freely permeable by water and air is apt to give a high mortality. We may quote what Ballard says on this point, "Dwellers on loose slabby rock, as commonly seen overlying solid rock, have more or less diarrhoea in proportion as the slabby material is in small pieces and mixed with looser earthy matter, or in larger blocks with little intervening earth. Clay soils, other things being equal, do not appear to be in themselves among those soils specially favourable to high diarrhoeal mortality. When they have seemed to be so, the connection has appeared to me to be otherwise explicable. A soil which is a mixture of clay, sand and stone (commonly called 'marl') is apparently favourable or unfavourable to diarrhoeal mortality in proportion as it is loose and permeable on the one hand, or plastic on the other."

"The presence of much organic matter in any soil renders it distinctly more favourable to high diarrhoeal mortality, than it otherwise would be."

Excessive wetness and complete dryness of soil appear to be both unfavourable to diarrhoea. A degree of moisture specially favourable is an amount

of habitual dampness which is decided, although not sufficient to preclude the free admission of air between the elements. It might be well to compare with these views the table of deaths from Cholera Infantum at Berlin during the summer months with the corresponding sub-soil water level, compiled by Hirsh, which seems to prove that the condition of the sub-soil water gives no measure of the rate of Mortality.* The same thing may be said regarding the fluctuation of ground water.

Table of deaths from Cholera Infantum at Berlin, during the Summer Months, with the corresponding sub-soil Water Level.

June.	Height of sub-soil water	Deaths.	July	Height of sub-soil water.	Deaths.	August	Height of sub-soil water.	Deaths.
1882	1.60	533	1880	1.47	1136	1880	1.42	448
1880	1.63	950	1882	1.51	829	1877	1.49	469
1881	1.71	508	1878	1.67	770	1881	1.52	480
1878	1.82	826	1877	1.69	1207	1878	1.55	431
1877	1.90	785	1879	1.75	991	1882	1.62	570
1879	1.91	816	1881	1.83	1293	1879	1.65	554

To this group the external atmospheric, sanitary, and hygienic causes some other factors must be taken into consideration, such as the density of the population, and the crowding together of dwelling houses. These are factors, however, which affect every

* Hirsch's Handbook of Geographical & Historical Pathology, Vol.III., p.385.

zymotic disease and have no special influence on Infantile Cholera in particular.

The population of London, as we have seen, increased in 200 years from 5,00000 to 5,000,000 but there is no corresponding increase of the mortality from Infantile Diarrhoea. Suggestions indeed appear to show that it has rather diminished in proportion to the increased population and the death rate from Infantile Diarrhoea now is only a little larger than the mean death rate from the same cause for England and Wales. This we have already alluded to in a former chapter. A distinction, however, has to be drawn between the increase of population and the density of certain areas. Increase in the density is usually followed by a distinctive increased fatality.

It is scarcely possible to mention any sanitary abomination which has not been alleged as a causal agent in the production of Infantile Diarrhoea. Noxious sewers, nauseaus smells, proximity of cess pools and ash pits, back to back houses, dirty and dismal surroundings, have all had their share of blame for creating outbreaks of excessive virulence of this disease. But the same argument holds good in any zymotic disease, and again has no distinctive reference to the exact causal agent of this specific

malady. In areas teeming with courts and closes, back to back houses where the air is still and confined one naturally expects outbreaks of diarrhoea at all periods of the year; but they do not seem suitable for classing in the group of zymotic or epidemic diseases. The water supply has also been blamed, but what infant of a year old drinks water in sufficient quantities to bring about violent diarrhoea. It is long since these causes have been blamed for exciting infantile diarrhoea and many improvements in town dwellings have been the result. Streets are built wider, back to back houses have been largely abolished, there are more open spaces, more light, better soil, less effluvia and better appliances for removal of unsanitary material.

Sanitary improvement, however, does not seem to have abolished the disease, even in those towns where improvement was most called for and where most has been done. In 1851 Leicester stood out prominently as a town virtually without drainage and without hygienic relations of importance. The death rate was exceedingly severe, especially in the years 1849, 1850 and 1851. The population for each of those years was 58,000, 59,000, and 60,000 respectively. The percentage of mortality among children under one year was roughly 28, 29 and 29

for the respective years. The birth rate and the mortality increased in almost arithmetical ratio with the increase of the population. This continued for many years until the deep drainage of the town was completed. In 1858 the Zymotic death rate began to fall. The improved drainage of Leicester in 1855 did not prevent an epidemic of fever in 1857 or an increase in diarrhoea mortality from 115 the preceding year to 202 in that year. It is strange that in 1858 "a cold, impoverished year" with an excessive local death rate the percentage of diarrhoea deaths was remarkably low. In 1860 the diarrhoea mortality fell to 56 as compared with 202 in the year 1856.*

Since 1837 more attention has been given to a group of causes which may be classed under those dependent upon the mother. Sir William Fordyce in "A New Enquiry into the Causes, Symptoms and Cure of the Putrid and Inflammatory Fevers, with an Appendix on Hectic Fevers, London, 1773, p.207 thought that** about 20,000 children in London, Westminster and the suburbs were ill with this disease, and that it was caused in the children of the upper classes by mistaken regimen and the improper manner in which children were reared, for says he,

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* Sanitary Record, London, 1879, X., 193, 196.

** A new Enquiry into the causes, Symptoms and Cure of the Putrid and Inflammatory Fevers, with an Appendix on Hectic Fever, Lond., 1773, p.207.

"They live in hot bed chambers, are fed on meat before they have teeth, on biscuits not fermented, on buttered rolls or tough muffins, calves' feet jelly or strong broths.

Every practitioner knows that the disease does not break out in debilitated babies and badly nourished babies only, but attacks children to all appearance healthy and sound and whilst most prevalent in epidemics amongst the children of the poorer class, it does not restrict itself to that class but visits the rich, well-nourished, well-housed, and well-clad in districts which could scarcely be called the poorer districts.

Creighton suggests that the outbreaks may be accounted for from the lowered vitality due to some inherited weakness from the parents, and illustrates this statement by observing that the most serious outbreak of this disease occurred in 1720 at the time of the drink mania, when the parents were constitutionally weakened by excessive intoxication. But our former study makes it obvious that the disease by no means attacks the weakest children who have lost the "stamina vitae" as suggested by Creighton.*

Ballard shows actually that 42% of deaths occurred among "Healthy" children as against 57% in

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* Creighton, Epidemics in Britain.

"Weakly" and concludes, "Our experience of these Leicester epidemics by no means supports an opinion commonly held that a summer diarrhoeal epidemic makes its first fatal swoop upon the weakliest children."*

From the figures given it appears that previous general health has very little to do with even fatal cases. It is a matter of common observation among practitioners that the fattest and healthiest children frequently succumb to the disease, while those apparently weak and staminaless pass through it alive. It is unfair to argue on points of this kind merely from mortality statistics, which are as we have seen the only ones available, but which take no account of the enormous multitude of cases of Infantile Diarrhoea which recover under treatment. In 1895 no less than 10,554 children died from Diarrhoea, and this represents a very small proportion of those attacked who recover. It may be true, however, that as a general rule weakliness has much to do with "speedy collapse of the most rapidly fatal cases and with the cases that last over 48 hours." Dr Ballard estimated that out of every 75 children 26 of those who died were not weakly.

Since it appeared from the first census Report that the brunt of the mortality fell upon industrial

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* Report to Loc. Gov. Board, pp.43-45.

towns where many women are engaged in some form of out-door employment, efforts have been continuously made by medical officers to place married women under some legal restriction as to the hours and periods of their labours, in some form or another. Dr Tatham would have women restricted from returning to work too soon after child-birth.*

Dr J. Reid is of the same opinion and would have mothers legally restrained from industrial occupation for some time after child birth,** while Dr Weir*** argues that it is futile to expect that "parents and guardians of the infant population will either reform themselves or be reformed while the sewer is held up as a source of every ill of babyhood," and suggests the following remedies as more likely to modify the high death rate from Infantile Diarrhoea than any other cause:-

1. Prohibition of Out-door labour among married women.
2. Curtailing of Boy and Girl Marriages.
3. Prohibition of Baby-farming.
4. Prohibition of Quack Drugs.
5. Postponement of Vaccination to the age of six months.

Since 1879 baby-farming has been prohibited, the vending of Quack Drugs placed under Act of Par-

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* Brit. Med. Jounr., 1892, Vol.II., p.277

** Brit. Med. Journ., 1892, Vol.II., p.275

*** San. Rec., London, 1879, X., 193-196.

liament; boy and girl marriages are less frequent; and in Leicester, at any rate, early vaccination would not be an agent likely to cause Infantile Diarrhoea, especially in the winter season. In Leicester the total births in 1895 amounted to 5960 of which 273 illegitimate births showed that boy and girl marriages were less frequent. It would be interesting to know what the author of these suggestions is going to do with these 273 children. In 1857 the deaths from diarrhoea were 202. In 1860 they were only 56, and in 1895 out of a population of 174,624 they rose to 362 in spite of the operation of the reforms suggested nearly twenty years ago.

Such regulations as these seem to be merely palliative at the best. No class of women are harder worked or labour under more trying circumstances of climate and occupation than the agricultural classes, whose children least frequently suffer from diseases of this kind. When their arduous bodily labour is compared with the work of women in Yorkshire and Lancashire, or in such towns as Leicester, Worcester, Northampton, Coventry, Norwich, Birmingham, Nottingham and Preston, it will be found that these women work under much better conditions than the women in agricultural districts, or

even than women engaged in charing, washing, scrubbing and other kinds of domestic work. In Preston 32% of the women work in cotton mills well ventilated, well lit, and with no excessive prolongation of hours. In Leicester 20% and in Northampton 13% are engaged in the boot-making trade, which means sewing, stitching, packing and such work, all of which are comparatively light occupations. The other industries for women are glove-making, silk-weaving and many other industries of a like nature.

In face of these facts it would be impossible to legally restrain women from working.

These suggested palliative remedies are based upon an absolutely wrong idea of the causes which bring about these periodic outbreaks.

Most of these remedies have been suggested on the supposition that the infants of these women are more likely to be neglected than if the women nursed them themselves, and this seems to be borne out in some degree by the exceptional mortality which exists among illegitimate infants, and Dr Ballard is inclined to think "that the whole question of the occupation of women outside the home resolves itself into the question of maternal neglect, with the substitution of artificial feeding for feeding at the breast."

The third group of causes are those in which the child itself has been alleged to be the main factor.

The maladies of infants have long been attributed to the causes summarized by Walter Harris in his work on "Diseases of Children" (1693)

" 1. To their catching cold.

2. To the too thick milk of the nurse.

3. To their over-soon eating flesh.

4. To the mad and imprudent fondness of Mothers and many nurses, who do often permit their infants to sip up wine and other strong and spirituous liquors."

Regarding the last of these items, it is interesting to note (See Chap.I., p.) the early American view as recorded by Rush, who recommends the use of "sound old Wine" in the summer months, from a teaspoonful to half a wineglassful every day, "because", he says, "children who sip the dregs of the wine that their mothers have been drinking are much less subject to this disease than the children of the poor. It is to the second of these causes that Harris attributes the great danger to "sucking infants". "Upon how inconstant and slipperie a plan doth the Health of these innocent children Sift! It's this, he says, "that are the frequent occasions why we hear so often the sound of passing Bells for some one child that is unde-

servedly atoning and expatiating the faults and mistakes of its nurse." He adds, "If this coagulated or poisoned food fall from their stomachs into the intestines then "Gripes and Colick pains, greenish excrements, and very often most dangerous fluxes do ensue." (Page 39) "From the middle of July to the middle of September, these epidemic gripes of Infants are so common (being the annual Heat of the Season doth entirely exhaust their strength) that more infants, affected with these do die in one month, than in other three that are more gentle."

This cause has even been enlarged upon in "song". The poet thus apostrophises the over-indulgent mother:

"Oh! be not tempted by his artless smiles
On fondness, that a mother's mind beguiles
To load his stomach with digestless meats,
But keep a medium in whate'er he eats,
Lest that wherewith great parent nature strives
(The better nurse) to lengthen infants' lives
And make their bodies grow, you misapply
And the poor child in dangerous sickness lie
From painful vomitings, and other woes
To which o'er loaded stomachs still dispose."*

Dr Underwood on this subject remarks (Vol.II., p.242) "So many little infants fall a sacrifice to the use of undigested food under the age of six months, being carried off by vomiting, purging or fits, that whoever would preserve them over the

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* Tytlers Paedotrophia, Lond. 1797, Bk.II. 92, 1, 515, 524.

most dangerous period of infancy cannot too cautiously attend to their diet at this time."

The following poem by Luigi Tansillo (1510) which evidently inspired Scevole de St. Marthe (born 1536) is a very interesting account of Roman customs about the beginning of the 16th century and throws considerable light on the habits of the Italian matrons of that period and on the custom of having foster mothers. The author gives his views very plainly on the nursing of children by their mothers.

"Were modern truths inadequate to shew
That to your young a sacred debt you owe,
Not hard the task to lengthen out my rhime
With sage examples drawn from ancient times.
(Z)

It would be strange indeed if the authority of antiquity should be required in support of a practice so essentially necessary to the very existence of the human race, as that of a mother giving suck to her own child; and it is certainly only as a satire upon his country-women that Tactitus notes this circumstance as a peculiarity in the manners of the ancient Germans. "Sua quamque mater uberibus alit, nec ancillis ac nutricibus delegantur." If the reverse of this had been true, and the historian had remarked that women of rank thought themselves degraded if they nursed their own offspring, and such task was therefore delegated to the lowest of the

people, it might have been thought extraordinary, and would have nearly rivalled the fashionable practice among the inhabitants of the South Sea Islands, of exposing their children; a practice much more similar, both in its motives and effects to that of sending out a child to nurse than is generally imagined. "An non expositionis genus est, infantulum tenerum, adhuc a matre rubentum, matrem spirantem, matris opem ea voce implorantem quae movere dicitur et feras, tradere mulieri fortassis nec corpore salubri, nec moribus integris; denique cui pluris sit pecuniae paux illum, quam totus infans tuus?"

Of Rome's twin founders oft the bard has sung,
For whom the haggard wolf forsook her young.
True emblem she of all th'unnatural crew
Who to another give their offspring's due. (aa)

This circumstance is differently explained by Faginoli who conceives that Romulus and Remus imbibed their ferocity with the milk that supported them.

E per prova si e visto infin, che quegli,
Ch' ebbe latte di bestia, fu efficace
A farlo bestia diventare anch' egli.
Ebbe Romolo, e Remo una vorace
Lupa per Balia; ed ambedue redaro
L'inclinazione sua ladra, e repace." *

Many writers of the present day still incline to this view of the causation of Epidemic Infantile diarrhoea, and the belief is not restricted to any

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* The Nurse, a Poem translated from the Italian of Luigi Tansillo by William Roscoe.

particular part of the world. Thus Mr H. F. Brown who long resided in Italy accounts for the high infantile mortality in Italian towns, crowded, dirty, and densely populated. Regarding Venice, he says, "It is a matter for wonder how any babies are reared in Venice at all. The women are so utterly ignorant of the plainest rules, so devoid of common sense, so jealous of their husband's interference, and so sceptical of the parish doctor, that infant mortality is appalingly high. Many a man will tell you that he has 8 or 10 children; but on enquiry it will turn out that only four or five are living. It seems that quite half of those that are born die in infancy, and a wife lays her account to lose her first three or four. She informs you quite calmly that it is difficult for them to live. Later on she may become a little more careful and experienced; but even so the waste of infant life is terrible and the dangers that surround the infant immense. If however, it does survive black coffee, sour wine, and raw apples freely administered during its first ten months, which bring on <u>groppo</u> (Infantile Diarrhoea), <u>convulso</u>, <u>riscaldamento</u>, and escapes the concoctions, lotions and prescriptions of the old crones of the quarter it will probably grow up into a fine and healthy man, robust, sane and happy.*

On the other hand Trousseau does not include "feeding" among his group of"causes". He attributes the main cause to the influence of "Season" and illustrates the fallacy of attributing feeding and bad hygiene as the main cause by quoting the case of his own grandson who required very vigorous and prolonged treatment; and by the case of two twin sisters, daughters of a rich bourgeoise who were so reduced by the diarrhoea that at 17 months old the one weighed 15 and the other 16 lbs., so that the nurse could not be induced to take them out for carriage exercise.

The modern scientific view is inclined in the direction indicated by Trousseau and which has received the confirmation of the experience and research of Dr Ballard. We quote his opinion on this subject.

"Although there is ground for the popular notions which associate epidemic diarrhoea with the consumption of articles of diet, the almost equally common notion that such diarrhoea arises from the indigestibility of food or from faulty digestion on the part of the consumer of it, is not, I am disposed to believe, so well founded; rather I am inclined to think that epidemic diarrhoea due to food, as arising from some extraneous substance in the food which substance is by itself a sufficient cause of the malady."

I will give his observations on this important topic in extenso:

(a) "As regards the influence of the mode of feeding of young infants, incidence of diarrhoeal mortality upon infants fed on the one hand exclusively on the breast and on the other hand partially or entirely upon other kinds of food is of special interest. The general conclusions arrived at by medical men who have studied the matter and by Medical Officers of Health who have adduced statistics in support of their opinion, are generally to the effect that infants fed from the breasts are remarkably exempt from diarrhoea, as compared with infants that have been fed otherwise; and that feeding from "a bottle" has been principally concerned in the fatal diarrhoea of infants. But my difficulty about accepting these conclusions in their entirety has hitherto been absence of data as to the proportion of healthy children fed in these different ways. In this difficulty Dr Hope, Assistant Medical Officer of Health for Liverpool, has come to my assistance and has made some comparative statistical enquiries among infants in that city who were healthy and among others who had died of diarrhoea in the summer season and the general result of his enquiry, so far as I have at present worked upon his tables, is this:

(1) That infants fed solely from the breast are remarkably exempt from fatal diarrhoea, even among the low class Irish, the degree of exemption being exactly the same among the Irish as among the English and other races in his city.

(2) That infants fed in whatever way with artificial food to the exclusion of the breast milk are those which suffer most heavily from fatal diarrhoea.

(3) That children fed partially at the breast, and partially with other kinds of food, suffer to a considerable extent from fatal diarrhoea, but very much less than those who are brought up altogether by hand.

(4) As regards the use of "the bottle" that it is decidedly more dangerous than artificial feeding without the use of the bottle.

(b) It is to be inferred from observations which I have made that the circumstance of "<u>food keeping</u>" and its exposure to telluric emanations (e.g. in underground cellars), or to emanations from accumulations of domestic filth, &c. (e.g. when kept in pantries, &c. to which such emanations have more or less free access) tends to render it liable to produce diarrhoea, especially where the storing place of food is dark and is not exposed to currents of air."*

* Ballard's Report to Loc. Gov. Board, 1888, p.6.

Modern views based upon such opinions incline, therefore, in the direction of attributing this periodic epidemic of diarrhoea to some organic changes produced by micro-organisms, or by some mechanical decomposition which may be dependent upon various factors for their existence, such as we have indicated - the conditions of season, conditions of soil, the presence of micro-organisms and of albuminous material. The food of the infant, therefore, is an etiological cause which must be carefully examined in a search for the causation of these outbreaks. How it behaves in the presence of bacteria or other organisms, what chemical changes it undergoes in the body, and whether from it by these agencies it is capable of producing some kind of substance which acts as a virulent chemical poison, produced by the body itself, and which may prove to be the cause of these epidemics.

The following is a summary of the more recent views on the Etiology of this Malady. Emmet Holt records that out of nearly 2000 fatal cases only 3% had been breast fed. This immunity is no doubt due to the fact that the milk they take is sterile and not swarming with organisms, as cow's milk is apt to be. He remarks that there is less plausibility about the disease being produced by sewer gas,

emanations from the soil, or the ingestion of sour milk, although each of these may contribute to the cases of diarrhoea, but not the invariable cause, because infants fed on sour milk do not invariably suffer from diarrhoea, and Ballard has pointed out that diarrhoea is not specially prevalent in some towns where sewer gas is constantly present in the house. There is a strong probability that milk is the vehicle for the entrance of organisms or poisons into the system.

Flugge has recently shown that some air bacteria are often present in milk; cow dung, hay seeds, street dust act on the casein, form peptones and ptomaines without turning the milk sour; but if this milk is injected into a guinea-pig it causes their death.

Baginsky failed to find any specific or pathogenic organism but found many saprophytic or non-pathogenic organism and thinks that the decomposition products formed by these various things are the producers of the poison.

Meinart believes it to be produced directly by the action of high temperature, and that it is really a sort of heat stroke, and has nothing to do with poisons at all.

The general tendency of the proof is that

summer diarrhoea is a definite zymotic (see Farr) disease, a high temperature favours the development of organisms, especially in milk, and produces many poisons, such as muscarine, which when taken into the stomach produce all these symptoms of irritant poisoning and as they flourish both inside and outside the body there is good reason for believing that they play a part in giving rise to severe diarrhoea.

Modern pathology is inclined to regard "Bilious Diarrhoea" as due to some such causal agent with which we are as yet imperfectly acquainted. The modern belief points to the theory of poisoning, which was the cry raised in Spain during the epidemics of the middle ages, and to regard some contamination of food or of water as the sourse of disease, but whether the poison is manufactured inside the body or outside the body is not yet clearly made out.

"We must look," says Dr Lauder Brunton, "to further observations upon the nature of the alkaloids formed by putrefaction; upon the effect of typhoid and other bacilli, on milk, eggs, beef-tea, and other foods used in typhoid fever, to a more exact investigation of the alkaloids formed in the intestine and found in the foeces and urine, and to experiments

upon the action of aromatic substances formed in the intestines, upon the liver, for further knowledge which may aid us in treating disease; but enough has been already done to show what important effects on the animal body are in all probability produced by the alkaloidal products of albuminous decomposition.* "

So far then, it would be necessary to make a more careful examination into the methods which have been adopted for infant feeding, and to enquire somewhat more closely how far the food of an infant may be capable of producing strong irritant alkaloidal poisons, and especially to direct more close attention to the qualities residing in milk.

* Practitioner, Vol.35, pp.268, 274.

CHAPTER IV.

POISONOUS PRODUCTS THE RESULT OF ALBUMINOUS DECOMPOSITION AS A CAUSE OF CHOLERA INFANTUM.

POISONOUS PRODUCTS THE RESULT OF ALBUMINOUS DECOMPOSITION AS A CAUSE OF CHOLERA INFANTUM.

"In Stercoribus animalium magna latet vis medica."
Paracelsus.

"Poisons, Madam," said the learned leech, "are of various sorts. There is your animal poison, as the lepus Marinus, as mentioned by Dioscorides and Galen." Dr Lundin in "The Abbot", Chap. XXXII., Scott.

In reviewing the works handed down to us by the Ancient Masters of Medicine, it is impossible not to be struck with the great care they bestowed upon the consideration of a proper dietary. Some foods were forbidden. The Assyrians despised the Babylonians because they ate fish. The Jew deprived himself of many viands regarded by other Orientalists as dainties. Jewish writers gave special heed to dieting and none wrote more scientifically or fully on this subject that Isaac Ibn Suleiman (855 A.D. to

955 A.D.) whose book on Dietetics and the Viatica was prescribed to the first Medical Students at Oxford.*

But it was in the time of the Arabs that food laws became predominating. For all these food prejudices it has been sought to provide medical reasons. But when the food prejudices of one nation are weighed in the balanced judgment against those of other nations, this position is at once seen to become untenable.

Even most modern physicians are aware of the signs of a poisoned sausage, with its dirty, greyish, green colour, its soft cheesy-like consistence, and its disgusting taste. The intensity of the poison symptoms depends upon the quantity ingested. The first symptoms occur from 18 to 24 hours after ingestion and include nausea, pain, diarrhoea, vomiting. Nervous symptoms supervene, paralysis of voluntary muscles occur, loss of vision, ptosis, dilatation of pupil and dryness of mouth. Nearly all old books of Natural History record travellers' descriptions of numerous cases of death from poisonous fish.** Autenrieth mentions 70 suspicious kinds of fish, most of which apparently are sea or salt water fish living in tropical seas. The Sting Belly of China and Japan are used for suicidal purposes.***

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* See Macalister's Lectures on Oxford University.

** Autenrieth ueber das Gift der Fische, Tubingen 1883.

*** Autenrieth, p.50.

Many fishes have names showing that they are poisonous, "The Betrayer", "The Purging Fish". the "Poison Fish", etc. The Jew would eat no oysters, no shrimps, no crabs, no lobsters, no mussels, no whelks, no stewed eels, lest the terrible consequences mentioned in Deuteronomy 28, 21, should fall upon them - plague (verse 22), pestilence, consumption, scab, itch, madness (verse 28) and even sudden death (Verse 66). But the potency of death does not solely belong to shell fish or to fish without scales. But by far the greatest number of cases of poisoning by fish have been due to fish which are very extensively eaten and which in themselves are not in the least poisonous, but which become so when decomposition has set in. That the effects of these poisons are not so common now is doubtless due to the stringency of our sanitary laws, which can compulsorily destroy in London alone nearly 50,000 tons of decaying fish in one year.

There is moreover, such a thing as idiosyncrasy in food. In many people such a combination as milk and beef tea will produce digestive discomfort, nervous symptoms, malaise, frontal headache and an unpleasant taste in the mouth, to all of which the name of "biliousness" is given. The bitterness cannot be due to"bile" which is not bitter and suggests some peculiar foreign substance which has been

secreted there by the salivary glands. Milk and eggs are reputed to have in many cases exactly similar symptoms, which when they are prolonged may affect the intellect, colour the conjunctiva yellow, and be followed by vomiting and diarrhoea. It has further long been known that meat, fish, cheese, and milk act as poisons when decomposition has been allowed to act upon them long enough, and that these poisons were often exceedingly virulent.

The Products of Proteid decomposition have long been noted for their potency as poisons, and history makes it clear that the ancients were familiar with their varieties in activity, and differences of virulency of many of the forms of Proteid matter. I have seen an Arab Manuscript on animal poisons, probably a compilation from Indian and Egyptian sources which clearly shows the Arabs largely used the products of the putrefaction of organic matter for the purpose of poisoning food and drink, especially stews and soups of their enemies and occasionally of their friends for the purpose of ensuring their death. They had noted the mode in which to prepare these poisons effectively, the period required for their action after administration, and the symptoms which preceded a fatal termination. This Manuscript perhaps gives the earliest and clearest account of

the poisonous action of animal poisons formed by albuminous decomposition, of which we have any full or scientific information. The Hindoos, however, probably long before this book was written, poisoned wells and foods with poisons prepared in the same way. In the Mediaeval ages the Jews were accused of doing this in Europe. These animal poisons were prepared by burying certain animals (usually small animals) for a number of days in a manure heap, and thereby producing as is now known by means of various bacilli some specially powerful poison. To render it more deadly the poison makers even in some cases inoculated an animal with some material (pathogenic microbe) or with snake venom before killing it or bringing about the decomposition of its tissues. Perhaps the Arab poisoners did not know that alkaloids to which the name of ptomaines has been given were formed by the dead bodies through the process of decomposition and that some of the poisons which they were using were identical with vegetable alkaloids. They knew, however, that these poisons varied according to the nature of the proteid, of the organism they inoculated and of the ferment which brought about the decomposition. There is unhappily every reason to believe that the ancient poisoners knew how to prepare potent animal poisons, how to

administer them secretely in food and drink to bring about the death of some undesirable person, and that the physicians of that learned people had to be prepared with the knowledge of treatment necessary to combat the conditions which were brought about by these agents.

The following will illustrate the mode of procedure. A young swallow was caused to be bitten by a viper, then squeezed between two copper discs so made as to fit close and then allowed to remain until it became gelatinized. This gelatinous mass was the effective agent, called the "Swallow Poison" in these early text books. The Arabs were particular in noting the symptoms. This poison produced violent pain in the epigastrium, great debility, and prostration and was so deadly that it killed the patient in one day. The treatment of poisoning like this was two-fold. They tried to ELIMINATE the poison by an emetic, consisting of snails and milk and radish water" not unlike the modern treatment for infantile diarrhoea so greatly extolled by Trousseau under the name of the "Eau-albumineuse" to which further allusion will be made. Subsequently they used an ANTIDOTE, in this case consisting of a preparation made of the "Ashes of the dung of the gazelle, of the sheep, and the urine of the cow all

rubbed up together." Prima facie it looks exceedingly unscientific, but when we remember how frequently it has been suggested by researchers that poisons produced in this way may at the same time tend to produce other alkaloids to neutralise the action of the poisonous one, the prescription may perhaps not be so surprising. It is not impossible that the alkaloids formed in the intestines of the gazelle or the sheep or in the urine of the cow do not actually contain the very antidote which would neutralise the ptomaines introduced into the intestinal canal by the poison formed from the decomposed swallow.

The Arabs did not only employ these for poisoning the food, but they also inoculated the body with certain poisons of a very virulent kind, as in the case of the well-known ring poison. One Arabic formula for the manufacture of this poisoned ring contains the brains of the gecko (a kind of lizard), viper gall, frog gall and hemlock. This was artfully but doubtless effectively prepared and concealed in the lower side of the ring stone in the signet ring.

Other poisons were prepared from the "gall of the black snake" from poisonous fungi (muscarine) and from henbane seeds.

Modern science has not recognised any advance upon these practical facts earlier than 1820 when Justinius Kerner published his work on *
He subsequently however inclined to regard the "Fatty Acids" as the poisonous agents. Others have long believed that poisoned foods contained acids, but Schossberger suspected organic basis as the cause. Majendie and Gaspard also made some researches on the effects of low organisms. In 1856 Panum was the first to conclude from his investigations** that the poison contained in putrid matter was chemical, a result which was subsequently verified by Weber*** (C.O.), Hemmer *=*, Schweninger =*=, Stich and Thiersch. Bence Jones and Dupre descovered a substance like Quinine in the liver =*=*. Subsequently Zuelzer and Sonnenschein obtained from putrid meat infusion, small quantities of a crystalline substance(an alkaloid) having an action like Atropine, which caused dilatation of the pupil.*=*=

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* Arch. fur Phys. Heilkunde, 1853.

** Bidrag til Laeren om den saalnalette eller septisce Infection. Bibliothek offic. Laeger.

*** Deutsche Klinik, 1864, 45, 51. 1865, 2, 8.

= (1866) Experimentellen Studien uber die Wirkung faulender stoffe auf den thierischen Organisms, (Munchen)

=*= (1866) Uber die Wirkung faulender organischer Substanzen.

=*=* Pharm. Centralhalle, 1866, XVI. 10.

== Berliner Klinische Wochenschrift, 1869, 12.

These products hitherto had received no precise nomenclature or definition. In 1870 Armand Gautier examined the secretion from animal bodies and found that "on distilling normal urines he could obtain an alkaline liquor containing tri-methyl-amine.

CH_3
CH_3 --- N and not merely ammonia.
CH_3

To the products of decomposing material from living bodies he gave the name of Leucomaines. About the same time Professor Selmi of Bologna, a toxicologist, applied the name "Ptomaines" to alkaloids produced by physio-chemical action after death.

At first these products of Albuminous decomposition were supposed to differ in nature from vegetable alkaloids although Selmi (1872) was careful to say that the substances which he had found "comported themselves in the presence of reagents precisely as the vegeto-alkaloids do." Indeed vegetable and animal alkaloids are both products of albuminous decomposition. There is no absolute distinction between alkaloids of animal origin and those of vegetation. There are only differences in detail which do not render less marked the resemblance which entitles them to be grouped together. "For whether they be the product of the organs of plants or formed from animal albumen by bacterial action or the cell vitality of superior organisms, vegetable

alkaloids, ptomaines and leucomaines have the same origin, the proteid material and are identical in their genesis - proteid disintegration." The alkaloid must be sought for in the Albumen Molecule.

This brief historical resume assures us that proteid substances, themselves foods, may be split up to yield matters which physiological experiment has demonstrated to act as poisons of varying activity and virulence. The molecular fragments of albuminous decomposition become dangerous as is illustrated by observing that peptones for instance when introduced into the blood produce loss of coagulability, fall of blood pressure and death. In the healthy body luckily these do not enter into the circulation. They are changed into globuline in their passage through the liver.

What was known to the Arab poisoners only by practice and results, namely, that the virulence of these poisons was influenced by the nature of the albuminous material undergoing decomposition is now capable of scientific demonstration. Thus Neuridind and Gadinine are non-toxic, while Muscarine, Neurine, and choline are extremely toxic. The rapidity of their formation is also influenced by temperature, moisture and electrical conditions. Thunder storms and electrical conditions of the air turn milk sour, especially in Dairies. In summer putrefactive processes go on more rapidly and become

more quickly poisonous than in the coöler winter temperatures, and thus it is not difficult to arrive at the generalisation that poisons may be formed in the moist and warm stomach after food is swallowed, although no poisons may be found in that part of the same food which was not swallowed. This fact doubtless has a direct bearing on the production of many obscure forms of diarrhoea, and is especially true with reference to milk albumen. (See Chap.5 on Tyro-toxin.)

It is clear then, that poisons may be formed outside the human body from proteid decomposition to which Selmi has given the name of "Ptomaines" and which, when injected or ingested into the economy, have a profound physiological action. The best known may be mentioned and described very briefly in this tabular form, compiled from material taken from Sternberg and compared with other sources.

	PTOMAINES	ISOLATED BY	SOURCE	PROPERTIES.
I.	NEURINE	Lebreich 1865 Brieger	Brain Muscle	Toxic in small doses, producing paralysis, stoppage of respiration and of heart in diastole, with contraction of pupil. Antagonised by Atropine.
II.	CHOLINE	Strecker 1862 Brieger Diakonow	Hog's Bile Many sources Yolk of Eggs	Toxic in large doses, Salts deliquescent.
III.	MUSCARINE	Brieger Schmiedeberg	Fish, Oxid^{n} of Choline The Fly Agaric	Highly toxic in small doses. No smell, no taste, syrupy, soluble in water, causes colic, vomiting, diarrhoea, disturbed vision, death in from 6 to 12 hours from loss of cardiac power. Use oleaginous purgations.
IV.	PEPTOTOXIN	Brieger	Early putrefaction of proteids	Very poisonous, soluble in water.
V.	TYROTOXIN	Vaughan	Cheese, Milk, Icecream, etc.	Vomiting frothy, stools watery, colic, nervous symptoms.
VI.	METHYL-GUANADINE	Brieger Bocklisch	1.Horseflesh 2.Oxid^{n} of Kreatine 3.Finkler Prior Bacillus (vibrio proteus) when mixed with others.	A highly poisonous substance causing violent diarrhoea (Choleraic)
VII.	MYTILOTOXIN	Brieger	Poisonous mussels	Symptoms like curara poison.
VIII.	TYPHOTOXIN	Brieger	From typhoid bacillus	Strongly alkaline.
IX.	TETANINE	Brieger	From tetanus bacillus Brieger obtained four poisons of which this is one.	Produces tetanus in mice.

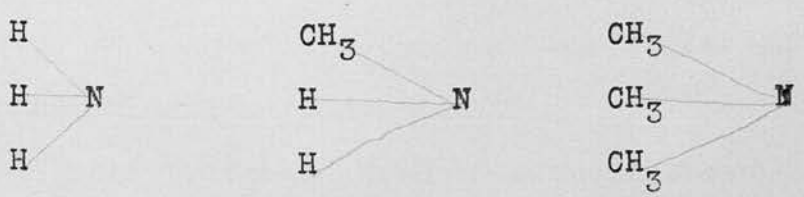
	PTOMAINES	ISOLATED BY	SOURCE	PROPERTIES.
X.	CHOLERA PTOMAINES	Brieger	Cholera Spirillum.	Diarrhoea.
XI.	TOXALBUMINS	Brieger and Frankel.	From pathogenic Bacteria, e.g.Diphtheria Typhoid Tetanus Staphylococcus Cholera Sp.	 Death in 10 days. Death in a few days Death in 2 or 3 days.
XII.	MYDALEIN	Brieger	Livers	Pronounced physiological action, causes secretion of all organs with involuntary muscle tissue paralysis of hind then of fore legs, fever and purgation.

A glance at these products convinces us of their terrible potency in bringing about the dreadful symptoms with which one is so familiar in the Diarrhoeal diseases, especially when they are introduced into the delicate and feeble organs of an infant, upon which even one drop of laudanum has so great a power. One can realise what the effect of these powerful animal alkaloids would be on such an organism if by chance they were administered to the infant.

In regard to infantile diarrhoea, however, these important facts would not at first glance seem to have any direct bearing as an etiological factor, because it would be unfair to conclude that since alkaloids are formed outside the body they must also

be formed inside. It is happily now demonstrated by Armand Gautier that alkaloids are not only formed in the living laboratory or organised protoplasm of the animal creation, but that they are excreted from it by almost every excretory organ. They have been isolated from freshly voided foeces, from urine, from bile, from saliva, and recently from sweat.* But so far as I am aware no researches have been made with the view of isolating alkaloids from freshly secreted mother's milk. The blood alkaloids are separated by the kidneys and excreted in the urine in greater quantity in disease, those from urine in different diseases differing in action.**

The first Leucomaine was discovered by Liebeg and Pettenkoffer in urine and it was called Kreatinine. At first all leucomaines were supposed to be ammonium derivatives or Amides like Methylamine or Trimethylamine and



Ammonium. Methylamine Tri-Methyl-amine

totally different from anything like vegetable alkaloids until Oscar Liebreich detected Betaine - a vegetable alkaloid only derived from Beetroots - in

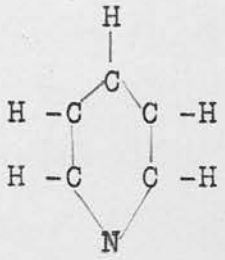
* See Comptes Rendu, Vol.CXXV., No.5, Aug.2, 1897, p.183.

** Lepine and Guerin, Lyons Medicale, 24, 1884.

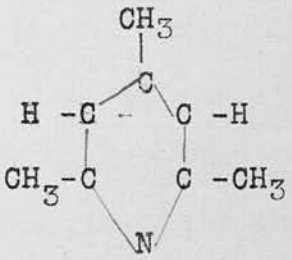
normal urine and proved their identity. Gautier subsequently affirmed "That the important chemical function of all animal tissues, however much it may have been ignored is an incessant elaboration of alkaloid products formed at the expense of proteid material precisely as urea and carbonic acid are similarly and simultaneously formed." To these he gave the name leucomaines, and limited the term to those alkaloids appearing during life and derivable from albumenoid substances. Their elaboration is too uniform to be assigned to any category of cells, neither, however , does it exclude bacterial action producing ptomaines in certain organs. It is plain, therefore, that the process of creation of these alkaloids does not depend solely upon the presence of micro-organisms which derive their vital nutriment from the destruction of proteid material - a function common to all living cells, but appeals to us also as a chemical discovery and indicates another cellular function.

The quantity formed even in a healthy man must be enormous - Bouchard thinks sufficient in 24 hours to kill him if it were absorbed. To strengthen this Lepine (Lyons Medicale No.42, 1884, and 24, 1884) describes a case of foecal poisoning causing death with symptoms of atropine poisoning.

The action of some of these alkaloids on the intestine is instructive. Pouchet & Villiers have isolated from Cholera dejecta a base which seems to belong to the Pyridine group of alkaloids. Pyridine may be regarded as a tertiary amine. One of the most important of the alkins, namely tropine, may be regarded as derived from Pyridine. Nencki discovered Collidine and Vaughan tyrotoxin from milk, all



PYRIDINE.



COLLIDINE.

of which are pyridin derivatives.

This intestinal alkaloid is apparently the product of albuminoidal bacterial destruction and is highly oxidisable.

The difficult question which arises in regard to the causal agency of these alkaloids is whether they are produced in the intestine or are conveyed into it ready formed. The specific case of Cholera Infantum seems to narrow the question down considerably, especially those cases of the disease which arise, as we have already shown they undoubtedly do, in young infants who have been entirely* breast fed.

* See Chapter on AEtiology, page

But even in such favourable cases the importation of alkaloidal poisons with the mother's milk would not altogether exclude Cadaveric Ptomaines, absorbed into the blood of the mother and excreted with the milk, from being a factor in the causation of Infantile Diarrhoea. Its importation into so many in the same district at the same period of the year would be a point very difficult of explanation. As a possible factor, however, it must be borne in mind. In the case of the healthy child is it possible that the mother's milk should apparently with great suddenness develop an irritant poison powerful enough to kill a previously healthy child in a few hours?

In the summer of 1885 Dr Cash made a chemical examination of some stools of infants who had died from Cholera Infantum, paying special heed to the character of the excretions, but chiefly with regard to the contained nitrogen. Unfortunately the cases submitted to him were only three in number, but these he analysed according to the methods of Dumas and Will-Varrentrapp, using the foeces in a dry condition. He found serum albumen in abundance and large quantities of casein, showing clearly that peptonisation had not been completely carried out in the intestinal canal. He found also that the Chloride and Phosphate of Sodium were increased and attributed this to the rapidity with which the food

had been hurried through the alimentary canal. In one experiment Dr Cash attempted to discover whether bodies having the characteristics of Brieger's Ptomaines could be isolated and indeed succeeded in obtaining a white crystalline powder of which he made a solution and tried its effect on a frog. From his results he wisely concluded that "it was premature to do more than indicate the possibility of the existence of some ptomaine-like body in the excreta of Infantile Diarrhoea." It is extremely regrettable that further reaearches were not persevered in upon this most important point.

Although the research of the Local Government Board was not productive of results which showed definitely that Infantile Diarrhoea was due to Alkaloidal Poisons, several results have been obtained by other Experimenters, both in this country and abroad. And the question which has now to be solved is, Is it the specific bacterium or ferment which is capable of producing those potent poisons? Some researched which have been made by myself tend fully to corroborate the alkaloidal origin of the disease.

During the Summer of 1890 I had the privilege of being able to perform the following experiments:

FIRST SET OF EXPERIMENTS

Done during Summer 1890.

The facies of this disease: The child generally plump and healthy, all of a sudden gets hot, restless and peevish, wishes to drink, perspires freely; just after a great quantity has been ingested, vomits and purges. This discharge after the first motion is highly offensive. With all this diarrhoeal discharge, the surface of body temperature is lowered, but "anal temperature is high," axillary 95°F., and anal 103°F. In another day, the loss of weight and flesh is considerable. There must be a great drain upon the blood serum. A great quantity of blood serum is evacuated by motions. Breathing is irregular and rather peculiar for a few minutes, say 10 minutes, is very rapid; the ratio between each respiration is equal but rapid, 46 per min. All of a sudden each respiration lengthens out and ten we get 20 per minute. There is no Cheyne-Stokes character about it.

J.G. at 9 months. Very warm week, wind S.W., gentle breeze, altitude 1020 above sea level. Parents healthy, no tubercle, syphilis or any other constitutional/

constitutional disease present; first child born, two lower incisors through. Fontanelle closed. Plump and healthy looking prior to onset. Called in June 1890; the child vomited yesterday, but had eight motions, very watery and highly offensive odour. Eyes sunken, darkened areola, condition of the bowels loose, abdomen flaccid, and the peculiar facies abdominalis, gurgling sound to he heard all over the abdomen. Temperature 103° axillary, anal 106°F. As soon as a little brandy was given, motion at once. Rapidly sinking. Took blood serum from index finger, three hours prior to death. Method of obtaining and precautions of injections: Hypodermic syringe, passed warm alkaline solution through it firstly, then warm $HgCl_2$ in 4000 through it, then warm alkaline solution (saturated). Then 5 mins. of blood serum injected into guinea pig, No.1. The part injected having been shaved and wasned and carbolised soap and $HgCl_2$ then injected between spinal column and shoulder of each guinea pig.

No.1 Guinea Pig died in 24 hours; evacuations very offensive and blood serum in great quantities. The other guinea pig was not injected that lived in the same chamber, but on the third day developed the same symptoms that the first had had, and died in/

in 75 hours. I presume that the second Guinea Pig must have taken some of the excreta of the first. This proves that the excreta contains an albuminate alkaloid, or virulent bacterial organisms.

P.M. The spleen was swollen and pulpy, very dark in colour. Liver fatty - this is very significant of poisoning by organic virus - compare with the fatty degeneration of Yellow Fever; and this was found in all of the other animals. Kidneys had cloudy swellings or they had all these characteristics, but in the second set of Experiments, the kidney of No.7 Pig was not affected. This pig was killed after injecting into No.8. This proves that the excretory products are inert at this stage and do not set up Glomerulo nephritis. This alkaloidal albuminate is soluble, but I believe that this can be found in the urine, but I have not isolated it.

"Has the centre that presides over the movements been localised in the brain?" In Meinart's theory we have a depressant state of the brain causing infantile diarrhoea*. What about the initiative phenomena seen; are they not the result of the active toxins on the central nervous system? In/

* See Gaskell, Journal of Physiology, Vol.VII., page 1.

In the exhausted stage of a rapidly fatal diarrhoea we often see spasms and twitching, and are not these the results of an irritated state of the brain? But according to Meinart's theory we have a depressant state of Central Nervous System, giving rise to irritative phenomena.

FLUGGI:

May not the Ptomaines produced by alkaline, and thus prevent precipitation of casein, but yet the serum of the milk be loaded with destructive ptomained? Consequently, when injected into a guinea pig it produced rapidly fatal diarrhoea. I injected milk obtained from the breast of a mother who had suckled a child who had infantile diarrhoea, but I did not here make a post mortem of the pig. I am sorry now. Did the pig die of the disease? Yes.

SECOND SET OF EXPERIMENTS.

I did prove that by injecting blood serum from one Guinea Pig to another, that at a certain stage an immunity was reached.

Blood serum of No.1 injected into No.2 Pig. 5 mins. of blood serum warm, part injected into the shoulder/

shoulder joint; 6 p.m.m clear and warm atmosphere; 10 p.m., pig crouching up at corner, had vomited, no purging as yet; 7.30 a.m. June 16th, purging and highly offensive yellowish green motions. Died June 17th, 9 p.m., convulsions and tetany.

Fatty Liver in all Pigs:

No.2 injected blood serum of No.1 into No.2. 5 mins., died in 75 hours, purges and vomits, highly offensive motions and blood serum. No.3 inject 5 mins. into No.3 from No.2; lived 70 hours. This one seemed to be the worst one of the lot, dying in great pain and convulsions.

P.M. Acute yellow atrophy of liver found. This may be only an accident.

No.4 pig died on the 4th day. Motions less, not so offensive. This one drank some of the mixture that was given him - Bismuth.

No.5 pig died on the 7th day.

No.6 pig had diarrhoea and vomiting up to the 14th day and then died. Diarrhoea very severe, but rallied by giving brandy and mixture Bismuth.

No.7 pig This one lived throughout and did not give the mixture - only brandy and water.

No.8 pig lived, no effect upon it) IMMUNITY
No.9 pig " " " " ") REACHED.

FIRST SET OF EXPERIMENTS.

Done during 1890-2.

J. W. - Parents healthy, no tubercle, syphilis or any other constitutional disease present in parents; first child born, age nine months, two lower incisors through, fontanelle closed. Called in June 10th, 1890. Vomited yesterday and had eight motions; eyes sunken, dark areola, bowels flaccid and peculiar facies abdominalis, respirations 30; temperature 104.6°; pulse 120. Bowels, gurgling sounds distinctly heard, and as soon as a little brandy was given, a motion took place. Sinking rapidly, 3 p.m., quite comatose. No motion since 1 p.m.

Treatment: Salol. Bism. Carb. Mist. Cretal. Brandy would not be retained, but mixture did.

3 p.m., June 10th, 1890, open by lancet index finger, and small incision and took blood, about 30 mins. in small bottle, which had been previously washed out antiseptically, and injected 10 min. of this blood serum into guinea pig.

No. 1: the injection was made above shoulder of Guinea pig. The hair and part thoroughly washed and shaved before injection. This animal died in 75 hours after injection of blood serum.

In/

In ten hours great prostration, vomiting and purging commenced. Evacuation highly offensive.

Post Mortem: Spleen very much swollen and pulpy. Mucous membrane of intestine highly congested. In some parts there was denuded epithelium of Lieberkuhn follicles, producing very minute superficial ulcers; great congestion around these ulcers.

No.2 Guinea Pig: This one was in the same cabinet as the No.1. I did not give No.2 anything to eat, but gave sterilised water. He commenced to be ill on the third day, i.e. 13th June, and died on 16th. It was not injected, but very probably ate some of the excreta of No.1

This proves that the excreta contains something that is highly fatal to pigs, producing fatal diarrhoea.

There is also an active alkaloid poison pervading the blood serum, probably albumin, etc., which is soluble.

Child - age nine months, first child of healthy parents. No tubercle history. Dentition two lower and one upper. Called in July 10th, 1892. Facies abdominalis, fontanelle closed. Eyes sunken, darkened areola. Vomits and purges dark yellowish/

yellowish, highly offensive odour, breathing rapid 23; temperature 103.6°F., pulse 120. Abdomen walls retracted and flaccid, gurgling sounds to be heard everywhere.

July 11th, 1890, 10 a.m. Atmosphere clear and a very warm night. The child to all appearances sinking fast. Three hours before death took a small quantity of blood serum and injected 10 min. under skin of abdomen of guinea pig at 10.15 a.m. same day. This animal died in 24 hours, great prostration in 10 hours and evacuations very frequent and highly offensive. The other guinea-pig that was in the same chamber also contracted the disease on the third day. Died in 75 hours after the purging of bowel commenced.

P.M. of Guinea Pig No.1 Spleen very large and swollen, pulpy. Microscopic examination - red blood corpuscles very numerous, and there were numerous little clusters of rounded cells with a kind of linking connection between these individual round spherules. The mucous membrane of intestine small; the Lieberkuhnian glands greatly enlarged, and also there as if coalescing together small superficial ulcers. The epithelium was denuded.

Guinea pig No.2. Spleen dark and swollen. The same character of the mucous membrane to be seen/

seen, the superficial small ulcers between the follicles of Lieberkuhn's glands.

The blood of No. 1 pig produced rapid fatal diarrhoea in mice.

The blood of No.2 pig did not produce rapid death, but the mice died in one week from inoculation.

Post Mortem: Fatty Liver. Cloudy swelling of kidney with interstitial changes taking place at pyramids, Malpighian, spleen enlarged, therefore chemico-actinic power must be in the blood, which is distinctive of tissue in these regions. Effete products are in the blood.

Child three months old. Healthy parents, no constitutional disease. Facies abdominalis, bowels very offensive odour. Twenty evacuations in 24 hours. Fontanelle depressed. Died in 32 hours after onset of diarrhoea; artificially fed, condensed milk "Milk Maid Brand"; never cleaned the bottle once in the day; if it wanted a refill did not cleanse the bottle. Apthae Stomatitis upon tongue two days prior to onset of diarrhoea. Anal temperature 103°F., Axilla temperature 95°F. one hour before death. Greenish yellow faeces, very offensive odour, flatus sulphuretted hydrogen smell/

smell (rotten eggs).

10 a.m. June 20th, 1895. One hour before death took 10 min. of blood from index finger and injected into two mice antiseptically. They both started purging during the night after 2 a.m. I went to bed at that time. The one died before 9 a.m., the other at 8 p.m.

Post Mortem: Experiments with milk from mothers sucking, puerperal, scarlatina, etc. Ten mins. of blood of Guinea Pig No.1.

Injected into	G.P. No.2	, died in	73 hours.
" "	G.P. No.3	" "	75 "
" "	G.P. No.4	" "	4 days
" "	G.P. No.5	" "	73 hours
" "	G.P. No.6	" "	6 days less diarrnoea.
" "	G.P. No.7	died in	8 days. 4 or 5 motions.
" "	G.P. No.8	died in	14 days.
" "	G.P. No.9	" "	20 "

No 9 diarrhoea first day, but not many motions, character yellowish green, no great odour, but the motion on third day semi solid. Kidney not affected, but fatty liver.

No.4 pig. Acute yellow atrophy. Interstitial nephritis well marked. Fatty liver always present, in the more severe types very well marked.

THIRD SET OF EXPERIMENTS.

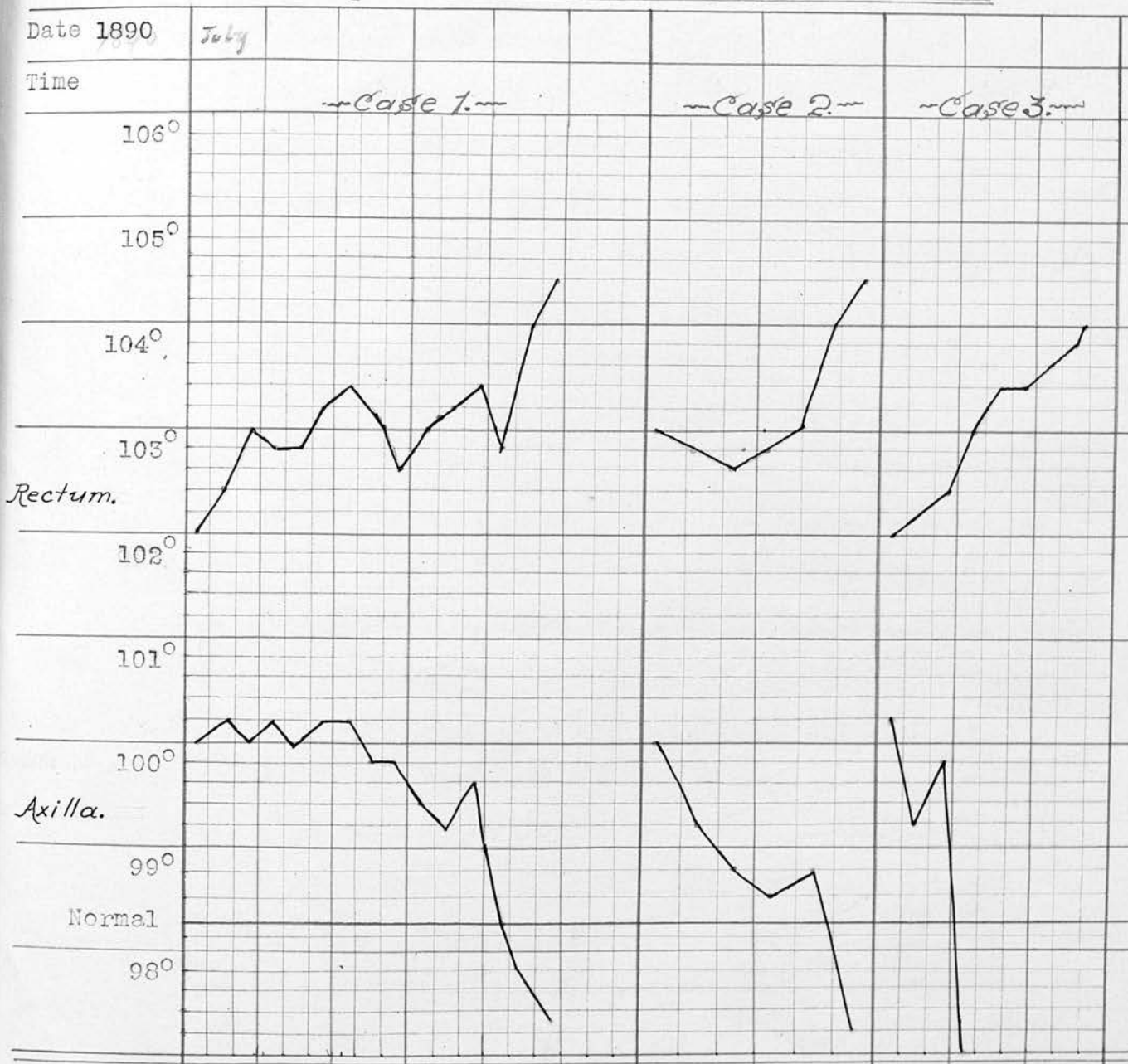
Injected milk into Guinea Pig who had no immunity, fatal Diarrhoea occurred. This milk had been obtained from the mother of a child who died from Infantile Diarrhoea. Five mins. of blood serum of this pig injected into No.2, produced the same results as first pig, but he died in greater agony. Convulsions and tetanic spasms of hind legs blood serum of this pig No.2, injected into No.8 of second set of Experiments - result, diarrhoea, but did not last more than one day, and the pig lived and this consequently was not fatal.

The blood serum of No.8 was injected into No. 9 of Second Set of Experiments - result, no diarrhoea, and the only thing observed was that the pig crouched for a few hours, but became quite lively.

The above, I believe, points out that that in the blood serum there is soluble albuminate which has a toxic effect upon the central Nervous System, and thus produces this fatal diarrhoea.

TEMPERATURE. CHART.

Shewing that BODY temperature, is lowered whilst RECTAL, " " " high.



	Case 1.					Case 2.		Case 3.		
Bowels	4	3	3	6	5	6	10	6	8	4
Pulse	130	136	140	140	150	140	150	136	150	150
Respiration	28	28	30	30	40	42	46	40	46	48

The facies of the disease is very well understood. The child, generally plump and healthy, suddenly becomes hot, restless, peevish, manifests a great desire for fluids, perspires freely after taking in large quantities of food, vomiting and purging begins, the first motion being scarcely offensive, but the subsequent motions highly offensive. Accompanying the diarrhoeal discharge the superficial temperature is low and the face pinched and pallid, while the anal temperature is high, axillary 95, anal 103°F. In 24 hours the loss of weight and flesh is considerable, showing that there must be a great drain upon blood serum which is evacuated by the motions in great quantities.* The breathing becomes regular, rapid for say 10 minutes, 46 per minute. At the end of that period there is a sudden lengthening of the respiratory sounds, and a decrease of about 20 per minute, = no Cheyne Stokes character about it.

One of these cases, J.G. aged nine months, fell ill during a warm week, wind south west, gentle breeze, altitude 1020 above sea level. Parents healthy, no tubercle, syphilis, or any other constitutional disease present, first child born, two lower incisors through, fontanelle closed, plump and healthy looking prior to onset. Called in June 1890, vomited yesterday, but had eight motions, very watery and highly offensive odour, eyes sunken, darkened areola, abdomen flaccid, and the

* Cf. Dr Cash's Report, p.13.

peculiar facies abdominalis gurgling sound to be heard all over the abdomen. Temp.103° axillary, anal 106°F., perspiring profusely. Two hours later, temperature 96 axillary, and anal 103°F. As soon as a little brandy was given motion at once. Rapidly sinking.

From this case by means of a hypodermic syringe carefully cleansed by means of an alkaline solution followed by corrosive sublimate $HgCl_2$, 1 in 40 strength, and followed again by a warm alkaline solution saturated, some blood serum was taken from an index finger three hours before the death of the infant.

Now with this blood serum so carefully obtained I proceeded to endeavour to demonstrate its toxic powers by injecting it into some of the lower animals. Five minims of blood serum were injected into Guinea Pig No.1, the part injected having been freed from hairs and washed with carbolised soap and corrosive sublimate. The injection was made between the shoulder and the spinal column in each case. This animal died in 24 hours with signs of Choleraic Diarrhoea, the evacuations being very offensive and containing great quantities of blood serum. Another Guinea Pig which lived in the same chamber was in no way affected and the third day

developed symptoms similar to those which had caused the death of No.1 Guinea Pig and it died 75 hours afterwards. The presumption is that the second Guinea Pig must have become contaminated by the food which had become soiled with the excreta of No.1 Guinea Pig. If so, it is a proof added to the number of proofs which have already been so elaborately described by distinguished researchers abroad that the excreta contains some poisonous material, and it may be, contains an albuminate alkaloid. On the other hand, it is quite conceivable that certain bacteria capable of producing albuminous poisons in the intestine may have been injected with the blood serum into No.1 Guinea Pig, and that the proliferation of the micro-organisms may have developed in the intestine sufficient toxins to kill the animal although not quite sufficient to destroy the micro-organisms themselves. It is conceivable, further, that these micro-organisms in the blood serum of Guinea Pig No.1 may have been conveyed into the intestinal canal of the accompanying Guinea Pig, and have produced its death within 75 hours. Without an elaborate series of experiments, one which would have included the administration to another isolated Guinea Pig of some of the excreta of Guinea Pig No.1 in the food would have been exceedingly useful.

From other experiments I endeavoured to prove that by injecting the blood serum from one Guinea Pig to another a certain stage of dilution could be reached when the animals injected seem to be immune to even very powerful blood serums, but the question of immunity will be dealth with in a subsequent chapter. One of the most curious facts which I elicited by way of experiment was that with milk obtained from the breast of a suckling mother whose child had infantile diarrhoea. A very severe diarrhoea in lower animals was produced. This so far as I know, is the only occasion on which it has been sought to prove that even in favourable cases where the infants have been entirely breast fed, ptomaines derived from the milk of the mother may be a potent factor in bringing about the disease. In what I have described as the third set of Experiments, the milk obtained from the mother's breast whose child had died from Infantile Diarrhoea was injected into a normal guinea pig and fatal diarrhoea occurred. The injection of 5 minims of blood serum taken from this guinea pig produced the same results, that is, death from fatal diarrhoea, but No.2 died in apparently greater agony, with convulsions and tetanic spasms of the hind limbs. From this Pig No.2, I injected Pig No.5 of the 2nd set of Experiments, which had been gradually immunised, with

the result that a Diarrhoea was produced, but it did not last more than a day and did not prove fatal to the animal. The blood serum of this partially immunised Guinea Pig was injected into another animal, No.9 of the 2nd Set of Experiments, and the result was that the pig crouched for a few hours and subsequently became lively without manifesting any diarrhoea.

We may sum up this chapter by recalling the circumstance that Brieger or any other investigator failed to find, or at least to isolate any ptomaines in the small intestine even a day after death.* They found, however, bacteria in plenty which might have produced them under favourable conditions. But in the normal condition of the contents of the small intestine there appears to be something antagonistic to the formation of alkaloidal substances. Several workers have suggested that the inhibitory effect may be due to the influence of the bile acids. It has also been suggested that some diffusion of oxygen takes place between the blood of the mucous membrane and the intestinal contents which cover its surface, and that it is the influence of the Oxygen which prevents the development of the poisons.** But under exceptional circumstances

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* Brieger, Deutsche Wochenschrift, 1887, p.469.

** Gamgee, Vol.II., page 435.

as for instance, the very conditions which we are investigating, some very potent poisons have been isolated.* Brieger isolated a highly poisonous derivative of Guanidine, the so-called Methyl-Guanidine and some others which seemed to have the property of reducing the surface temperature and causing coldness and pallor of the skin.

At the present state of our knowledge, it is impossible to say with any certainty what the nature of the alkaloid is which produces this terrible consequence, and it is still more difficult to say by what means it is produced. Many volumes might have been written on the experiments which have been conducted with a view of showing that the ferment enzymes bacteria, saprophytes and organisms of a vegetable nature have all played their share in bringing about the formation of these poisons. At present the question demands still further investigation and a further appeal to that forecourt of philosophy, the laboratory of the experimenter.

At the same time there is much to be known regarding the nature of those organisms or ferments which have been credited with the causation of the Diarrhoea in infants by various investigators. Of these we propose to give as concise an account as is compatible with the extended nature of the subject.

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* See Table, page
Brieger, Uber Ptomaine, Dritter Theil, Berlin, 1886, p.33

Before doing this, however, it would be well to call attention to an alkaloid which has a peculiar interest in reference to the causation of the milk diarrhoea of infants, to which we have already alluded under the name of TYRO-TOXICON, isolated and described by an American named Vaughan.

CHAPTER V.

TYROTOXICON AND OTHER MILK ALKALOIDS

AS AN ETIOLOGICAL FACTOR.

TYROTOXICON AND OTHER MILK ALKALOIDS

AS AN ETIOLOGICAL FACTOR.

"In Paradise," says the Koran (XVI., 28) "there are rivers of milk whose taste never changes." The ancients were very particular about the mode of using this animal secretion. Dioscorides shows (Kuhens' edition) that particular attention was paid to its component parts and that serolactis (whey) had in itself a laxative action on the bowel. He discriminated carefully between the properties in this respect of the serolactis from sheep's milk, asses' milk, mare's milk and sums up by saying "milk is nutritive to the body, softens the bowels, and cures flatulence." The influence of season upon the quality or properties of milk had also attracted his attention, for he says, "Spring Milk is laxative." The milk was also in his time observed to be modified by the food of the animal as well as the season and goat's milk is spoken of by him as being astringent after the animals had eaten oak leaves or pine leaves, and as being specially beneficial as a gastric sedative after these animals had eaten the White Hellibore.

The/

The Arabs specially attended to the mode of preparing milk for food. Cow's milk was preferred and in the Koran we find the recommendation to "use cow's milk, for the cow feeds on every plant." Richard Burton points out that the milk drinking races prefer curdled milk to fresh milk.* The nomads always use it in the curdled form.** He explains that they did this on scientific principles "choosing the fermentation to take place outside rather than inside their stomachs." "Amongst the Somali," he says, "I never saw a man, woman or child drink a drop of fresh milk, and they offered considerable opposition to our even heating it for coffee."***

One thing is certain, the ancients believed very little in artificial feeding of children and had many maxims enjoining the necessity of the mother acting as nurse to her own child. The oldest of those accounts come from Pliny.*=* He says:- "The mother's milk is the proper nourishment for infants."*==* And in another instance says, "A woman ought to be the entire mother of her child. "How contrary to Nature," he continues, "is this imperfect/

*Richard Burton's Arabian Nights, Vol. VII., p.360.

**Ibid, vol. VI., p. 201.

***Ibid, VII., p. 360.

*=*Book XXVIII, 9.

*==*Book XII, 1.

fect sort of mother, this mother by halves, who brings forth and then casts off her Offspring, who after having nourished in her womb and with her blood something which she did not see, does not now nourish with her milk what she sees living, becoming a human creature and imploring the assistance of its mother."

The Koran enjoins as a religious duty incumbent upon mothers the feeding of children by the breast until the child be two years old,* and it was a custom handed down from the Akkadians, the Egyptians and other nations of remote antiquity, the breach of which duty was always regarded with a kind of awe, the rearing of a child without the assistance of the mother becoming the topic of innumerable legends and the source of many of our most ancient myths.

It has been said that the person who invented the feeding bottle has destroyed more lives annually than Napoleon killed in all his campaigns, and the feeding bottle has been alleged to be the only provision in modern times to really take the place of famine, pestilence and war of the middle ages. Fortunately for the sake of the bottle, on a large scale it is only a comparatively modern institution, although/

*Mahomet's Rules relating to Women, No. VIII.

although artificial feeding of children was by no means a thing unknown to the ancients.

Artificial feeding does not absolutely require the use of the feeding bottle, and although this apparatus has advantages over the spoon or cup, many persons, rightly as it seems to me, prefer the spoon. The use of the feeding bottle certainly goes back to remote antiquity. A picture discovered at Herculaneum shows Silenus quenching his thirst with wine which we sucks from the point of a vessel shaped like the horn of an ox. The point of the horn was pierced with a number of holes,* and recently, Count de Reuss discovered about 50 feeding bottles when he was making excavations near Liege, obviously of Roman make and used by Roman nurses for feeding children. Curiously enough the word "REPLE" (fill again) was found upon each of these vessels.**

In these Roman bottles, the nipple was placed on one side, the principal opening was closed by a stopper pierced with several small holes to resemble the human nipple, and an aperture at the neck permitted air to enter.

Long/

* M. Marin, Essai sur l'allaitement artificiel des enfans nouveaux-nes.

** Journ. de Connaissance Utiles, Nov. 1832.

Long before this period artificial feeding had been resorted to, and in the annals of the ancients, whether it be true or merely poetical licence, we read of animals being used to supply nourishment when the maternal fountain had failed. Romulus was suckled by a wolf, Sirus by a bitch,* Telephus, the son of Hercules, by a fox, Pelieus, the son of Neptune by a mare, and lastly, Aegisthus by a she-goat. Tradition relates that all these celebrities imbibed the characteristics of those animals and displayed them throughout the whole of their subsequent life. Perhaps the first mention that we have of the deliberate artificial rearing of children has been handed down to us on the testimony of Antiphanes, who tells us that the Scythians, a very strong and numerous race, gave their children immediately after their birth, the milk of domestic animals. This treatment was specially adopted by that nation to get rid of certain diseases which the children evidently caught from their Grecian nurses. This was at the time of Alexander the Great. From that time forward there has always been a prejudice in the human mind against artificial feeding of infants, and that prejudice has existed in nearly every country and by no means among uneducated people. It/

* Talbot. A Fragment of Assyrian Mythology, in Transactions, I., pp. 272-277.

It exists in England to the present day, and many Scotch mothers still hold the traditionary views which have been handed down to them from the time of Antiphanes. Many mothers will not rear their infants on cow's milk lest they grow up clownish and vulgar, rude and coarse, both in appearance and behaviour.

Every school boy will recollect Virgil's allusion to this idea:-

"Nec tibi Diva parens generis nec Dardanus auctor
Perfide, sed duris genuit te cautibus horrens
Caucasus, Hyrcanoeque admorunt ubera tigres." *

"Neither did your Divine parent of lofty birth nor Dardanus O perfidious one beget, but the terrible Caucasus bore you bristling with hard rock, and the Hyrcancan tigresses gave thee their breasts.

If the records were examined, doubtless cases of artificial feeding could be found in periods much more remote than those already mentioned. The conditions of the early life of Moses** lead one to the probability that the child was fed by some artificial means. But the records of even earlier periods than that, tell a similar story regarding Sargon of Akkad, B.C. 3800, who, after he had grown to manhood and power, tells the story of his birth on a cuneiform tablet thus:- "My mother was a princess, my father/

* Virg., Eneid, Lib. IV., vers 365.

** Exodus, Ch. II., verse 5-9.

father I did not know him. My mother, the princess conceived me and secretly gave birth to me. She placed me in a basket of reeds; she shut up the mouth of it with bitumen, she abandoned me to the river which did not overhwelm me. The river bore me, it brought me to Akki, the drawer of water, etc."* The Egyptians, however, were most indulgent in the rearing of their children, apart from all artificial means. The mother had charge of the child during infancy. She nursed it for three years and carried it about on her neck.** The Egyptians do this at the present day. In a papyrus, written by a scribe called Ani, 3500 B.C., we find the following admonition given to his son, Khosuhetpn, referring to the care of his mother. He says:- "When thou wert born, after thy months were fulfilled, she placed herself under a heavy yoke in earnest. Her breast was in thy mouth for three years."***

The great difficulty, however, seems to have been not so much in the construction of a bottle as in inventing some arrangement whereby the child could obtain food out of a bottle, and in the supplying of some form of artificial nipple. That idea/

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* Dawn of Civilisation, Maspero, p. 597, 1896.

** Erman's Life in ancient Egypt, p. 163.

*** Maspero "Struggle of Nations", 1896, 4° p. 502.

idea only dates back some three and a half centuries. Nipples are mentioned for the first time in 1296. The feeding vessel consisted of a vase shaped as a kind of rough imitation of a nurses' breast.. The most original form of combining a nipple and a suction tube was a simple roll of linen, with one extremity dipped in the vessel containing the milk. This was superseded in later times by a piece of sponge put into the neck of the bottle and projecting about an inch above the aperture and covered with cambric or muslin fastened over it by means of a thread which fulfilled the double function of covering the sponge and of regulating the milk supply. Directions were always carefully given, however, that with this form of tube frequent cleansing was very necessary. The modern form of bottle really belongs to the present century, and was invented by Madam Breton (A lady who was chief mid-wife to the Maternity Hospital at Paris) who describes herself as "Inventeur brevetee des Mamelons artificiels et des Biberons applicables a l'allaitement naturel et artificiel."

Prior to her time the great difficulty was to provide proper nipples for children to suck. The old-fashioned bottles had two pieces of parchment for/

for the infant's mouth. At Constantinople this nipple was more suitably replaced by the teat of a goat, and which has the spongey elasticity of Nature.

The French were the first to use glass vessels for this purpose and to recognise the superiority of glass over horn, earthenware, wooden or metal ones. Madame Breton's bottle was made of crystal, and the neck of the bottle was closed with a glass stopper shaped like a nipple. This fulfilled all conditions of cleanliness, but it is obvious from the price at which the lady sold her patent feeding bottle, that they could not have been within the reach of those who most required them. In the year 1826, Madame Breton's teat

Mounted with Ivory cost ..... 9 francs
" Boxwood " ..... 5 "
Plain bottle " ..... 7.50 "
Stronger one " ..... 8 "
Coloured and ornamented from 9 to 11 frs.

She sent them to the provinces and charged 75 centimes for packing them. When the teats got worn out, she replaced them or remounted them at a uniform rate of 4.50 francs.

Now-a-days the bottle is cheap and is almost universally used, and in bad hands it is always a vehicle/

vehicle of danger. M. Gueniot, Acad. of Medicine, Paris,* said the bottle was good, but it was the hands that prepared and administered the food that were to blame. The cheap gutta percha used for tubing and nipples of these bottles is another element of mischief. The infant mortality due to this is very great. It is almost impossible to keep the interior of the india rubber tube of these bottles clean. It invariably smells strongly of acid. Any person who has seen a baby farm where children are allowed to lie for hours sucking at these bottles will not be surprised to find the apparatus reeking with Butyric acid. This acid, which these babies swallow, causes acute intestinal pain and diarrhoea.

There is not perhaps so much to be said against the so-called slipper bottle in which the teat is set directly in the neck of the bottle like the ancient Roman type. This gives the nirse a good deal more trouble, but is much safer for the child.

Milk albumen is easily split up into acid products and every medical man has seen this happen in cases of typhoid fevers, and especially in cases of pneumonia/

* See Report, October 7th, 1882, also Report of 1874 given to Directors of Public Assistance.

pneumonia. I have seen a man suffering from pneumonia and hiccup, with great flatulence, loss of appetite, inability to eat, who began quickly to sink. On examining the milk jug, I found the milk which had been given to him was sour and that the vessel which contained it had not been washed for three days. The milk got more sour in the stomach, underwent putrefaction, caused indigestion, diarrhoea and the death of the man, although he might readily have recovered from the lung condition.

Sir R. Thorne Thorne accords with the view set forth by Dr Ballard that the organism can undergo most rapid multiplication, and becoming air borne as the result of physical actions "such as the rise and fall of sub-soil water, it can gain access to the food supplies and above all to the milk which is so commonly stored for infants in miserable pantries opening out on to small confined areas and yard spaces, where emanations from filth accumulations blend with those forced out from the soil itself. "In this way," says Dr Thorne, "the organs find, according to Dr Ballard, an appropriate medium for undergoing those life processes which end in the production of a virulent chemical poison. Milk/

Milk thus infected," he continues, "may be deemed to constitute a common vehicle for conveying to the infant this poison, the results of which are so terribly fatal in some of our large towns." *

Further, it appears that a great danger exists in the milk which is not sour, but just on the turn with a small quantity of lactic acid already present in it. If half of the milk is given to the patient and half set aside in a cool place, that which has been set aside will, to all appearance, be all right at the end of two hours, but it will be different with the other half which has been put into the warm stomach. It will become acid directly. In cases of stomach disorder, the bacilli instead of being destroyed by the gastric juice as they are when the stomach is healthy, will commence to grow and multiply, set up fermentation and form also large quantities of acid, so that in some of these cases the adult patient will tell you he is alternately a gas works and a vinegar factory.

Infants are pretty much in this condition especially those fed artificially. The milk supplied to them does not come straight from the breast to their/

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* Watt's Dictionary of Chemistry.

their stomach and consequently is more apt to undergo processes which result in fermentation and putrefaction. That milk is capable of undergoing dangerous changes in the alimentary canal will perhaps be best illustrated by describing the researches of Victor C. Vaughan who discovered a poisonous substance in milk to which he gave the name of TYRO-TOXICON. This TYRO-TOXICON is described by Watt,* as a poisonous substance formed in milk, which has stood for some days, containing butyric acid ferment.

Some samples of cheese had produced alarming symptoms in many patients (about 300). Vaughan isolated from this cheese a highly poisonous ptomaine, to which the name tyrotoxicon was given. It signifies cheese poison, or casein poison.

When administered to students, this produced symptoms of dryness and constriction of the fauces, nausea, retching, vomiting, purging. Vomiting frothy, stools watery, accompanied by nervous symptoms of depression.

This poison was subsequently also isolated from milk which had been kept four months in a well-stoppered bottle. Then from several gallons of normal milk/

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* Watt's Dictionary of Chemistry.

milk which had been allowed to stand in a work room, but tyrotoxicon was not formed until three months after the experiments were begun. The poison was so potent that 10 drops of solution placed in the mouth of a small dog three weeks old, caused frothing at the mouth, retching, vomiting of frothy fluid, muscular spasms over the abdomen and watery stools.

This chemist subsequently received a request to analyse 2/3rds of a pint of ice cream which had seriously affected 18 persons. On adding distilled water and agitating and filtering, the filtrate was tested for tyrotoxicon and the result was given to a cat, which, within ten minutes, began to retch. This continued two hours. Next morning it had diarrhoea. Subsequently, its stomach was unable to contain any food. The animal was observed to lap a little milk, but it immediately began to retch, even water producing this effect. The animal was then placed under ether and the abdominal organs examined. Stomach and intestines were filled with frothy, serous fluid, mucous membrane white and soft, not the slightest redness anywhere, liver, etc., normal. It appears that young animals were effected by this poison more readily than old ones.

The/

The following is the particulars of the poisoning from ice cream:-

Vomiting and purging two hours after eating, of a soapy character with watery stools, griping in the abdomen, occipital headache, back-ache, pains in the bones. This lasted for two hours. Thirst, temperature normal, tongue dry and chapped. These symptoms agree with those produced on the cat. In the Brooklyn Board of Health Report, 1885, a case of poisoning of 100 persons from ice cream is recorded. Mineral poisons were not present. In the sample analysed, Butyric Acid was found and Vaughan thought there might be an intimate relation between Butyric acid fermentation and the production of that poison.

These alkaloidal bodies seemed to be formed by the fatty acids acting upon nitrogenous or albuminous substances in a state of semi-putrefaction. Lauder Brunton thinks that from the action of the substance, it may contain two poisons. This is altogether possible, but that it is the chemical body produced by fermentation there can be no doubt. Milk undergoing lactic acid fermentation has no such poisonous properties as tyrotoxicon and does not seem to be connected with ordinary decomposition of/

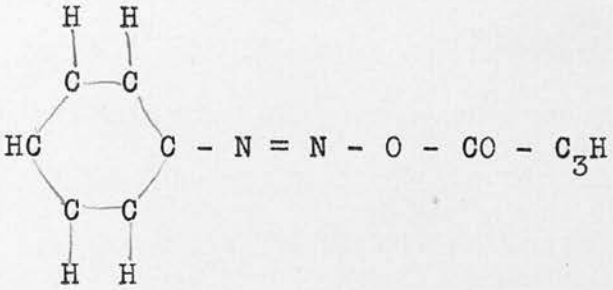
of milk. The following is an account of the milk from which the ice-creams were made (written by the maker of the creams.)

The milk from which this was made was fresh, cream of the night before only being added to it. The custard was made about noon and frozen under apparently proper conditions. The lemon cream was frozen first, then the Vanilla cream in the same manner, the best material being used,(the same milk in both instances.)

It appears that the fermentation going on in the custard and probably begun in the milk was arrested in that portion flavoured with lemon, by the freezing which was begun immediately, but while the lemon cream was being frozen, that part of the custard which was being made into vanilla cream, continued to ferment and before the freezing process was begun, enough of the poison was generated to seriously affect those eating it. He thinks the large amount of albumen in the custard hastened the fermentation and it has been proved that a large amount of albumen in cheese renders decomposition more easy."

Brunton alludes to the manner in which this poison is developed, to which he gives the name of Butyrate/

Butyrate of di-azo-benzene, which has the following graphic formula:-



It forms readily in cheese and in milk in hot weather and produces symptoms of nausea, vomiting, quick pulse, headache, laboured breathing, diarrhoea, great prostration and stupor. The pupils may be dilated, but not so much as in atropine poisoning. There may be a scarlet rash over the body as in atropine. This substance, he says, in all probability causes the diarrhoea in children. When milk is exposed to the hot air of a room, it gives rise to formation of tyrotoxicon or other more or less poisonous products in the intestine itself. This would occur the more readily when children are fed by means of long tubes, generally imperfectly cleaned. The bacteria would rapidly multiply in the warm stomach of the child and speedily cause decomposition of the milk and the formation of irritant products. There can be little doubt/

doubt that choleraic diarrhoea, just like Asiatic Cholera or Typhoid fever is due to microbes, although at present, bacteriologists have not yet succeeded in definitely settling the nature of the bacteria in each case. In Choleraic Diarrhoea, it is probable that the microbe only acts in a secondary way and that it is the product of the microbe which causes the poisoning effects in the intestine, and further, one must always consider the possibility of the poison being formed not only in the intestine, but in the blood or in the tissues.

We may conveniently conclude this chapter by noticing that the present view of the breaking up of milk in the intestine is the formation of lactic acid from milk sugar. It is this which causes milk to turn sour and it is brought about obviously by certain bacilli or cocci.

Hueppe has made very profound and comprehensive investigations on the Morphology and Biology of the bacteria of lactic acid in his work,"On the Investigations on the Curdling of Milk by Microorganisms." *

The peculiar curdling of the milk which the formation of "Kefir"** causes the bacteria of lactic/

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* Communications of the Imperial Officer of Health, Vol. II., p. 309, 1884.

**

tic acid to combine with the yeast fungi to produce alcohol and Co_2 of the Kefir milk. It is curious to note that this "Kefir" milk remains fluid, apparently peptonised.*

It is probable that we are here brought back to the starting point and that the ancient Arabs, in the process of curdling their milk with the rennets of the various animals, peptonised it and to a certain extent lessened its capacity for producing bacteria or for undergoing further fermentation outside the body.

It is well-known that milk forms a very suitable basis for the cultivation of bacteria for laboratory work, in spite of its want of transparency, because it allows certain biological peculiarities, produced in consequence of the growth of certain kinds of bacteria, coagulation, acid formation and colouring matters.**

Although it is by no means certain that the only way of forming poisons, even epidemic poisons is by means of organic life to the entire exclusion of chemical processes, we conclude this chapter by pointing out what is evident to all investigators that milk, its properties and its possibilities, furnish a very fruitful field of investigation and its/

* Baumgarten's Mycologie, p. 60

** Baumgarten Mycologie, p. 189.

its study and examination will well repay those who are intent upon knowing accurately the agents at work in the fluid, and in this connection the researches of Vaughan take perhaps a premier place and are of first rate importance. He has succeeded in isolating crystalline bodies which produce symptoms not unlike those of Infantile Diarrhoea, which we have already described. He has gone further and has succeeded in isolating from cultures of bacteria, which have been isolated by William Booker, substances which produce vomiting, purging and sometimes death in dogs. We cannot do better than support the belief of this investigator, that there are many bacteria which may produce Diarrhoea in children by acting on milk inside or outside the body. The consideration of these organisms, their history and mode of action will form a fitting chapter of this work.

CHAPTER VI.

BACTERIOLOGICAL ORIGIN OF INFANTILE DIARRHOEA.

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BACTERIOLOGICAL ORIGIN OF INFANTILE DIARRHOEA.

All modern investigators are agreed that everything points in the direction of a bacteriological origin of Infantile Diarrhoea. The search for a specific factor has been diligently pursued and myriads of bacteria have been discovered and tested with that assiduity and perseverance which have characterised all important discoveries in medical science. The atmosphere has been explored in the search for these bacterial causal agents. The soil has been searched and the foods scrutinised with the greatest bacterial acumen for the purpose of discovering, isolating and bringing under control, the deadly elements which victimise yearly more than has ever perished by the sword, in record epochs of bloody battles.

In the alimentary canal, throughout all its different portions, from the nasal mucous membrane, from the cavity of a decayed tooth, bacteria have been isolated, which have been accredited from time to/

to time as the actual agents. The stomach and its contents, the intestines, large and small, the excretions and secretions have all come under the serious consideration of modern investigators. So keen has the research proceeded, that Professor Miller startled the International Medical Congress when it meet in London about eight years ago, by explaining to the bacteriological section that he had been able to discover and isolate over 800 bacteria from the buccal cavity alone.

In the course of this investigation, it is obviously impossible to mention or particularise all the bacteria which have been associated with Infantile Diarrhoea, obtained from the intestinal tract or from the motions of infants so suffering. Our endeavour will be, therefore, restricted to indicating generally and broadly how our knowledge on the subject at present stands and pointing out and describing the organisms which appear the most closely associated with the disease.

A very important series of Experiments was conducted by Dr Tomkins, Medical Officer of Health for Leicester (1887).*

In the course of an outbreak of Summer Diarrhoea/

* Lancet, August 20th, 1887, p. 362.

hoea which occurred year after year, in Leicester, with great virulence, Dr Tomkins made some observations and cultivated Bacilli which were always present in obduction cases. *

He even mentioned that he had obtained Bacteria from small Ulcers in the bowels, which were said to be distinct because the culture which he obtained from them could never be procured pure and developed a specific odour during four or five generations of cultures. Dr Tomkins was able to obtain more cultures with the same odour from the atmospheric air, taken from the streets situated in the town at a lower level. If small numbers of cultures were transferred to animals, they got severe attacks of Diarrhoea. Dr Tomkins believed in the etiological connection of these atmospheric bacilli with Summer Diarrhoea.

It is not necessary to explain how much is still wanting to be able to lay this down with certainty, but we will give the statement for what it is worth in his own language. Thus he says, "but probably of much more significance than the foregoing are the results of the examination of the atmosphere. I have examined the air and the streets of the lower parts of the town, air from sewers in the/

* See Baumgarten, Mycologie, Vol. II., p. 737.

the same district, and compared it with the air of the higher districts where the disease is comparatively absent, with the following results: examined on the same lines as before, by means of cultivation in nutrient gelatine, the air in the streets of those parts of Leicester where the disease most prevails, and where the sewers are in the worst condition, as to cleanliness, etc., the number of organisms per cubic metre varied from 2000 to upwards of 5000 or 6000, the latter being obtained from air from sewer ventilators in the middle of the streets. Whilst in the air of the more open higher districts, they varied from 60 to 80 to 800 or 900 per cubic metre. The growth of these was slower than in those cultivations derived from the organs of the bodies, but with the air from the sewers, the gelatine was ultimately liquefied in the same manner, and in these cultivations an odour was perceptible of the same offensive character, but much slighter in degree to that before mentioned."

These results appeared two years before the publication of Dr Ballard's Report and Dr Tomkins sums up his results thus: "Although it is far from being proved that this Diarrhoea is the result of some form of bacterial life, yet I would submit/

submit that one is justified in saying that there is evidence to connect these organisms with the prevalence of the disease." *

Curiously enough, the local Government Board in the course of its investigation, published 1887, made no mention of experiments of this nature; it only speaks of the atmospheric temperature as conducing to a high mortality, exerting indirectly a very great influence, and it notices also** the effect of restricted circulation of the air and speaks of emanations from sewers as influencing epidemic diarrhoea, but no investigation was made into the atmosphere as a breeding ground for bacteria.

Some experiments have been quite recently conducted on the subject of the soil as a cultivating medium for bacteria, and Sir R. Thorne Thorne in a lecture*** delivered before the Midland Medical Society, endorsed and amplified the views regarding the influence of the soil which had been laid down in Dr Ballard's Report. He went still further, saying, "There is a strong presumption since the late Dr Edward Ballard's researches that the question of soil is in this disease a most important factor/

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* Lancet, Aug. 20th, 1887, p. 363.

** Local Government Board Report, 1887, p. 2.

*** Lancet, November 6th, 1897.

factor, and that the essential cause of it is bound up with the life processes of a micro-organism, not yet definitely differentiated, which exhibits its fatal manifestations in the superficial layers of the earth. The differing circumstances of the soil seem to have a most important influence in determining whether the organism is to live and multiply, or whether it is to be deprived of its power for mischief." He believes that "in presence of organic matter of towns, its vegetative vitality is likely to be ensured."

So much importance does Dr Horne place upon the influence of soil bacteria in producing this disease by contamination of air, water, milk, or other forms of food, that he makes the following crucial statement: "I would venture to maintain that no milk from the mammary gland of the mother ever caused death of an infant from this specific Summer Diarrhoea."

Of course, there are very different views on this subject both statistical and bacteriological. Every practitioner of medicine has seen cases of healthy breast-fed children succumbing to this disease. Why should the emanations which convey bacteria into articles of food prove poison to a child/

child, and those poisons take no account of the mother? The soil conditions to which the Medical Officer of the Local Government Board attributes so much infant mortality must to some extent affect articles of diet consumed by the mother, and if so, it is probable that the toxins thus ingested are excreted through the mother's milk, notwithstanding the fact that these poisons so fatal to the infant may be perfectly harmless to the suckling mother. All investigators agree upon this point, that in the infant "toxic effects may result from substances that are harmless to an adult." *

The action of the bacteria does not take place through the direct invasion of the micro-organism, but through the absorption of poisons formed by them and it is probable that these poisons may have a predilection for the milk glands, and that being so, they may be excreted in the mother's milk. At all events, this is the case with certain poisons, as for instance poison of puerperal scarlatina, which it is well-known can be communicated to the infant by the mother's milk and which can be conveyed to animals by milk innoculations.

We have already alluded to the fact that alkaloids/

* Allan Macfadyen, Brit. Instit. of Preventive Medicine, Brit. Med. Journ., Sept. 12th, 1896, p.628.

oids have been isolated from nearly every excretion of the animal body, from foeces, urine, bile, saliva, sweat,* but we are unaware that any careful experiments have been conducted with a view of isolating alkaloids from freshly secreted mother's milk. It was this that led us to undertake some investigations on this point in the course of which we injected milk obtained from the breast of a mother who had suckled a child suffering from Infantile Diarrhoea into some Guinea Pigs, with fatal results. One Guinea Pig into which we had injected milk obtained from the suckling mother of a child who died from Infantile Diarrhoea, also died, and some of its blood serum, (5 minims,) was injected into another Guinea Pig which produced similar results except that the latter one died in greater agony, accompanied with convulsions and tetanic spasms of the hind legs. From this animal, innoculation was practised to another again with similar results, which led to the formulation of the belief that in the milk serum of mothers there exists a soluble poison, most probably of an albuminous nature, which is capable of causing death when innoculated into the lower animals.

While/

* See Cap. IV. p. 10.

While then, we do not attribute the soil bacteria to have an effect directly upon Infantile Diarrhoea, there is yet no doubt that it plays a very important part in modifying the behaviour of bacteria, especially in such diseases as typhoid fever, ever since Pettenkofer expounded his views as to the relation between soil and infective bacteria. But Fluegge points out that the following question arises, "Supposing that the soil exercises some direct influence on one or several of the infective agents, whether this influence must be regarded as absolutely necessary for the epidemic spread of the diseases in question, or that a necessary and specific role must be assigned to the soil, or whether the spread of the same disease may not frequently occur in other ways without any connection with the soil?"

This can only be decided with a more accurate knowledge of pathogenic bacteria, and we await with some degree of eagerness for the publication of the results on this subject, upon which Mr Sydney Martin has been engaged. For our present purpose, it is enough to refer to what has been already said in Chapter III., pp. 6, 7.

Ever/

Ever since any knowledge of this disease has been obtained, the main incidence of mortality has always been placed upon the food. This we have already shown. Modern investigations point also in this direction. Researchers have discovered and developed bacteria in those foods which have been specially supplied to the nourishment of infant life. Milk being the staple article of infants' diet, has formed a rich field for the investigation of bacterial life, both as regards therapeutic and bacteriological purposes. In the laboratory it has been found possible to use this fluid as a basis for cultivating bacteria, in spite of its want of transparency, because it allows certain biological peculiarities of bacterial action to be investigated, such as the coagulation of milk, formation of acids and the production of colouring matters, as in the case of Le Sage's experiments.* Milk has furnished for the bacteriologist a much more fruitful field for investigation than the intestine, and an enormous multitude of bacteria has been isolated and described from milk cultivations.

We shall first mention the Bacilli, Acidi, Lactici/

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* Baumgarten, Mycologie, p. 189.

Lactici; (lactic acid bacteria); the latter was the first probably demonstrated in milk by Sir Joseph Lister. It has a power of forming lactic acid, more especially from lactose (milk sugar). But this is not the only organism which can produce lactic acid from lactose. Fluegge mentions the following list:- *

1. All pyogenic organisms, especially staphylococci.
2. Bacillus Oxytoxus Perniciosus.
3. Vacterium coli commune ...) (ESCHERICH.
4. Lactis arogenes .....)
5. Bacillus Prodigiosus (Hueppe)
6. He comes to the conclusion that there are more than 15 species of lactic acid producing bacteria, but adds one is especially named the Bacillus Acidi lactici because of its wide distribution and the intensity of its effect.

Hueppe first described the so-called Bacteria Acidi Lactici, but it is probable that it is the same organism as that isolated by Lister and Pasteur.

It is impossible in a short paper to go into the conditions of lactic acid fermentation. We can only mention the fact that this change is one of the first which milk undergoes, either outside the body, or whenever it is ingested. It does not seem/

* Fluegge, p. 304.

seem to have the power of peptonising the casein, as some other bacteria can do.

The further reduction of lactic acid is brought about by another series of bacilli to which the name Bacillus Butyricus has been given. Fluegge describes four kinds of Butyric acid producing Bacilli.

Bacillus Butyricus
" " (Hueppe), p. 372.
" " (Liborius), p. 371.
" " (Prazmowski), p. 367.

We have described in a previous chapter the action of butyric acid, which is the product of this Bacillus, and its relation to infantile diarrhoea; but Hueppe also mentions that it produces peptones, leucin, tyrosine, ammonia and substances with a bitter taste.*

This Bacillus Butyricus is also called by the name of Clostridium butyricum and Bacillus Amylobacter.**

Hueppe's Bacillus Butyricus seems to be of much importance. The organism was unable to cause the fermentation of milk sugar directly. It could only form Butyric acid when the milk sugar had been dehydrated by other bacteria, or when lactates were present/

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* Fluegge, translation, p. 612.

** Fluegge, p. 366.

present. They also cause coagulation of the casein and produce peptone, leucine, tyrosine, ammonia and substances with a bitter taste. The coagulum of casein, which is at first precipitated from sterilised milk by the Butyric acid bacilli, presents, after about eight days, an appearance as if its edges were being eaten away and it gradually disappears almost entirely." *

Sternberg devotes an article, p. 677, to the consideration of bacteria in articles of food. He mentions the colouring bacteria as being not so harmless as those which form organic acids. Milk is coloured blue by the presence of B. Cyanogenus, yellow by B. Synxanthus, red by B. Prodigiosus, bluish-red by bacterium lactes erythrogenes.

Regarding the quantity of bacteria found in milk, it is interesting to observe Sternberg's statement (which I regret to be unable to verify for want of the reference) that Professor Renk found in the milk supply of Halle from 6,000,000 to 30,000,000 per cubic centimetres.**

Cohn and Neumann have shown that the milk of healthy/

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* Fluegge, p. 372.

** Sternberg, p. 679.

healthy suckling women frequently contains bacteria. The Staphylococcus pyogenes albus is the species most frequently found. Ringel in 1893 examined the milk of 25 women, 12 healthy, 13 sick. "In three only was the milk sterile: in 17 Staphylococcus pyogenes albus was found: in two cases Staphylococcus pyogenes aureus: in one case both albus and aureus: in two cases Sraphylococcus pyogenes albus and Streptococcus pyogenes. The Streptococci were found in a case of mild puerperal fever and in a case of phlebitis." This clearly proves that the lactic secretion is a medium for the excretion of pathogenic organisms and poisons.*

Sternberg concurs with Baginsky (p. 585) and with Fluegge in believing that the toxins produced by bacteria are the usual cause of Summer Diarrhoea in infants. He says:- "But there is no reason to suppose that any particular micro-organism of this class has a specific role in the etiology of affections of this class. Probably the Bacilli of the Proteus Group and of the Colon Group are more frequently than others, responsible for Gastro-intestinal troubles in children. They are widely distributed and multiply with great rapidity under favourable/

* Sternberg, p. 679.

favourable temperature conditions, in milk or other article of liquid food." *

It is curious to compare the mortality statistics which have been attributed to the milk supply and the food supply as a factor in causation of high mortality. The following statements are gathered from an excellent paper on the advantages and disadvantages of the use of sterilised milk for infant feeding, by Dr H. Johnstone Campbell of Bradford Infirmary (B.M.J., Sept. 12th, 1896). He alludes to the fact that in Berlin, where milk is generally boiled before being used, 750 children under a year old, who died out of 10,000, were artificially fed. We presume that this implies that the remaining 9250 had been breast fed. Observe the Manchester statistics for August and September 1895 on this point. Of 500 deaths, Dr Niven makes out that 97% were hand fed babies, leaving only 3% that is, 15 babies who died who were breast fed. It is strange to find Dr Hope of Liverpool arriving at about the same percentage (See Ballard's Report.) Dr H. Johnstone Campbell gives Fluegge's figures, which we tabulate as follows:-

DR FLUEGGE:-

Of 79% children

1.3 were breast-fed.
7.9 mixed (cow's and humam)
18.7 cow-fed
51.1 milk and other foods.

* Sternberg, p. 585.

It has been said that of all foods, milk is the one most likely to convey infection to children, yet here we have 51% of children fed with other foods besides milk.

We will not consider the organisms of ferments found in the mouth or stomach of the suckling child, but confine ourselves to what remains to examining the views of investigators on the contents of the intestinal canal. It appears to be the bacteria of the small intestine which play the greatest part in health and disease. Although no Ptomaines of bacterial origin have ever been isolated in the small intestine, there exist especially in the alkaline part of the small gut, that is, in the upper portion of the intestinal tract, hosts of Bacilli which play the part of breaking up carbo-hydrates into organic acids. It has been definitely proved that they assist the enzymes in breaking up sugars into lactic and acetic acid, carbonic acid, but the main function is that which Masloff has shown that without the influence of putrefactive organisms, the succus intericus has no action on proteids, albumens are not converted into peptones, the changes brought about by the introduction of proteids being entirely due to putrefactive organisms. Under normal conditions/

ditions no ptomaines are found in the small intestine, although there are plenty of bacteria. This is probably brought about by the influence of the bile acids, or by the diffusion of oxygen which takes place between the blood and the mucuous membrane of the intestinal canal. In exceptional cases, ptomaines, some non-toxic, others highly toxic, have been isolated by Brieger from the small intestine.*

It is obvious from the fact that the meconium of infants has been shown by Escherich to be entirely free from organisms, to be sterile indeed, that the cocci, yeast, and other organisms subsequently found in the small intestine of infants are conveyed there by the food.

Fluegge, p. 724, says:- "Enormous numbers of Bacteria are met with in the intestinal tract. Numerous forms are found even in the contents of the stomach. It has been erroneously assumed that the acid contents of the stomach kill most forms of bacteria; this is, however, not the case. Experiments which have been made by Macfadyen in Fluegge's laboratory have shown that even the strongly acid gastric juices of the dog can kill only cholera and anthrax bacilli with anything like constancy, that however/

* Brieger Uber Ptomaine Dritter Theil, Berlin 1885, p. 33.

however, most other bacteria are not so susceptible to the action of the gastric juice, and can pass in a living state through the stomach even when conditions are as favourable as possible for an energetic action of the gastric juice, among bacteria which behave in this way may be mentioned micro-coccus tetragenus, staphylococcus aureus, bacillus cuniculicida, etc.

Hence there is for the most part only a temporary hindrance to development in the stomach, and vegetative forms, such as spores, reach the small intestine in a living condition in large numbers. There they find a good opportunity for development so long as the reaction of the chyme remains neutral, or faintly alkaline; it is true that this multiplication appears to be limited chiefly to certain definite forms of bacteria, so that in spite of the multiplicity of forms and varieties which strike one at first, there are some which evidently find in the intestinal contents a particularly favourable soil for multiplication, and occur there almost constantly."

The action of the organic acids formed by these organisms is particularly inhibitory to their growth. For example, lactic acid combines with the sodium carbonate (Na_2CO_3) of the intestinal juice. The excess/

excess liberates bile acids and plays a part in preventing putrefactive changes in the small intestine. Some parts are insensitive, such as the butyric acid bacilli.

The saprophytes are most numerous because they are easily grown, but other bacteria not uncommonly grow in the folds of the intestinal wall and may develop into a source of danger to the body, "partly by means of their ptomaines and partly by penetrating into the intestinal wall and causing infection." * Gamgee points out that no enzymes exist in the small intestine, but when albumen is introduced experimentally, peptones can be formed (Markwald) and these are absorbed. This is effected by the micro-organisms which have a powerful action on the carbohydrate constituents.

It is to the large intestine that one looks for the specific action of the various bacilli which having escaped from an acid medium now find themselves in alkaline surroundings where they can flourish luxuriantly among the Fibres Detritus, pigment granules, flakes of albumen, Vegetable Fibres, Starch Granules. There are few anaerobic bacteria which do not find in the contents and temperature of the large intestine a suitable habitat. Fermentation/

* Gamgee, Vol. II.

tion, which goes on in the small intestine, seems mostly to affect the carbo-hydrates and not the proteids, the formation of lactic acid preventing putrefactive bacteria from acting upon the proteids, but in the large intestine putrefaction is essential to the changes which shall convert the unabsorbed intestinal residue into faeces.*

It is exceedingly difficult to separate between organisms normally dwelling in the large intestine and those which are obtained from examination of the dejecta either in health or in disease. The number is so great that it is impossible in an article like the present to do more than mention what appears to be the most important species which have yet been isolated from faeces and the contents of the intestines. Non-pathogenic ones need not concern us in an investigation into the bacteriological causes which bring about Infantile Diarrhoea. The main pathogenic ones mentioned by Sternberg are:-

Staph. pyogenes aureus,
B. typhi abdominalis,
B. Septicaemiae haemorrhagicae,
B. of Belfanti and Pascarola,
B. enteritidis (Gartner),
B. of Lesage,
B. pseudomurisepticus (Bienstock),
B. coli communis (Escherich),
B. lactis aerogenes (Escherich),

* The germicidal value of Butyric acid is said by Koch to have failed to destroy anthrax spores after five days immersion. Sternberg, p.179.

B. cavicida (Brieger),
B. of Emmerich,
B. Coprogenes foetidus (Schottelius)
B. of Utpadel,
B. leporis lethalis (Sternberg) and others of Sternberg,
Proteus Vulgaris (Hauser),
B. tuberculosis,
Spirillum cholerae Asiaticae,
Spirillum of Finkler and Prior.

From Sternberg it appears that the Bacter. Col.Commune has been isolated by Escherich under the name of the Colon Bacillus and appears to be something like Emmerich's Bacillus (1885) obtained from the dejecta and blood of Cholera patients, and Weisser says he isolated it in the following year from normal faeces, and it has been shown to be commonly present in the faeces of healthy men and the lower animals.*

There is, however, absolutely no means of judging the accuracy of these statements, as the author (Sternberg) within the pages of his "weighty" work gives no references at all. One is left in the position therefore of "taking his statements or leaving them," and one is sometimes inclined to do the latter. He furnishes the information that pure cultures of this bacterium injected into a Guinea Pig cause the death of the animal in from one to three days.

This/

* Sternberg, 468, 471, 578.

This Bact. Comm. Coli seems, according to this authority, to play an important role in Cystitis, etc.. But his work is a mere compilation without the dignity of quoting the authorities to which it owes its origin.

Of these it may be remarked that Bienstock isolated four organisms from human faeces, which he considered to be concerned in albuminous decomposition, producing NH_3 & CO_2, to one of which he gave the name B. Putrificus Coli. *

Perhaps the most industrious investigator in this connection was William Booker, who isolated 33 kinds of bacteria from cases of Infantile Diarrhoea in great variety, but having no constancy in the types which were isolated. He found the bacterium coli commune in the faeces of suckling children and observed that it increased in proportion to the severity of the disease.**

Fremlin's studies (1893) showed that they possessed the common character of gas producers in sugar medium. Dreyfus in (1894) notes the difference in virulence according as they are obtained from healthy or sick persons. A culture from Cholera nostras was exceedingly fatal to Guinea Pigs/

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* Zeit. fur Klin. Med., VIII.

** Arch. fur Exper. Path. und Pharm. XXVIII (1891), p. 311. See Booker, Studies in Infant Cholera.

Pigs. It seems that the virulence of Colon Bacilli like others of its class, is increased by disease. It was Dr Bischler who originally observed that the Bact. Comm. Coli had both in the large and small intestine, an intense action on sugar giving rise to energetic fermentation and producing Ethyl Alcohol, Acetic Acid and dextrogyrous para-lactic acid.*

Gilbert gives five principal types (1895) of relations to this Bact. Comm. Coli of which the Bacillus Lactis of Pasteur and Lister, i.e., the Bac. Lactis of Escherich and the Bac. if Endocarditis are the most important.

Booker also found Proteus Vulgaris in considerable proportion of cases of Diarrhoeal discharges, but never in the faeces of healthy children. It seems to be next in frequency to the Bac. Com. Coli and Levy thinks that in flesh poisoning this Bacillus is at fault as the causal agent. (Sternberg p.) Escherich in Milk faeces found:-

I. The Bacillus Coli Communis
II. Bac. Lactis aerogenes.

These have an intense action on sugar and develop alcohol and paralactic acid in the small intestine. These organisims appear to act as ferments/

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* See Biologie de Bacille Typhique Memoir p. 11).

See Baginsky Zur Biologie der normalen Milch Koth bacterien. Zeit. f. Phys. Chem. XIII., 1889, p. 353.

ments and in the infant intestine attack milk sugar and produce acetic acid and lactic acid and CO_2 and H just as they are produced in the adult small intestine. * Macfadyen says these Bacteria of the small intestines decompose Carbo-hydrates in the acids and give the contents of the small gut an acid reaction and assist in the prevention of putrefaction, but he did not find any specific organism to which he could assign the cause of Infantile Diarrhoea, although he thinks that an abnormal formation of acids by bacteria in the intestine may be one of the main factors in producing Infantile Diarrhoea.

The specific cases which have been examined both abroad and in this country have led to but little result, the researches in this country being especially weak and unsatisfactory, more particularly those examinations which have been made under the auspices of the Local Government Board. During the able investigations conducted by Dr Ballard, many cases were submitted to Dr Klein for microscopical and pathological examination. The meagreness of his Report makes us earnestly regret that investigations of so important a nature should not have/

* Brit. Med. Journ., Sept. 12th, 1896, p. 628.

have been separately reported upon by more than one expert. England, fortunately, has several competent Bacteriologists who would have been glad to undertake separate examinations, and in this way the one-sided, one-man results which appear to weaken the general excellency of Dr Ballard's work, would have been avoided. The mere fact that there were two or three separate specimens from the same source would have stimulated the research and been more productive to medical science and more in harmony with the intentions of the Local Government Board than the meagre report which we will now proceed to deal with.

Of the eight cases submitted to Dr Klein, he reports (p. 84) in reference to his examination of hardened and preserved viscera. In none of the specimens thus sent was there any organism present, either in the tissues or blood vessels. The following is Dr Klein's Report of the only case (Case 6, p. 81 of the Report) in which he has found a micro-organism on post mortem examination.

The case was one of the typical acute summer diarrhoea admitted into the hospital in Great Ormond Street, and which ended fatally with fits of Eclampsia. In the cavity of the intestine there were found/

found numerous mobile bacilli, which in shape bore resemblance to the bacilli known as occurring in typhoid fever. These bacilli were also found on microscopical examination of secretions of the swollen mesenteric glands, but were not numerously present there.

From these glands, cultivation experiments were made on nutritive gelatine, the bacilli were thus isolated and pure cultivations obtained. Comparing these cultures with those of the typhoid bacilli of Gaffky, a striking resemblance is noticed:-

(a) They look alike in microscopical inspections.

(b) They grow alike in plate cultivation.

(c) They grow alike in broth.

(d) They are very much alike in stab and streak cultures on gelatine and on agar-agar mixture.*

Comparing the two in respect of their action on animals, it is found that when inoculated into white mice, they produce in a large percentage of cases, death under septicaemic appearances; the bacilli could be recovered from the heart's blood by cultivation. The difference between them so far as I can at present see is:-

1. That this bacillus from the case of Infantile Diarrhoea grows on gelatine more rapidly than Gaffky's typhoid bacillus, and/

* See Annual Report of Medical Officer for 1886, p. 447.

2. That the former has a somewhat greater resisting power to perchloride of mercury than the latter."

This was the case of a child of four months old, fed on a mixture of breast milk and cow's milk (p. 81). The liver had micro-cocci in plugs, in the capillaries and in the lobular lymphatics, in the kidneys were clumps of micro-cocci in the large vessels and in the large intestines there was a total loss of epithelium.

But Dr Klein, besides examining the organs, also made a report on the examination of Diarrhoeal stools which had been submitted to him in the course of the year 1882. He describes the stools as those of children "suffering from chronic diarrhoea, for example, associated with a chronic peritonitis, tuberculosis intestinalis, scrofula and various other wasting (not ascertained) diseases, and I find in them various kinds of Bacilli and various kinds of micrococci."

He mentions the following:-

(A) A mobile spore bearing bacillus, Bacillus Amylobacter, that is Bacillus Butyricus.

> Cruickshanks in his Bacteriology, p. 502, describes this organism as consisting of Rods 3 to 10 micro-metres by 1 micro-metre, often indistinguishable from Bacillus Subtilus. They grow out into long apparently injointed threads. They are mostly active mobile, but also/

also occur in Zoogloea. The rods and threads are sometimes slightly bent, like vibrios. They are anaerobic. The shorter rods as a rule swell in the middle. (Illustration can be obtained from Cruickshanks, p. 503.) There are many species described. For example the Bacillus Butyricus (of Botkin), (of Hueppe) varying somewhat in properties and results, but all having the power of converting lactos into lactic acid.

(B) A Bacillus, mobile, but shorter than the former, and in its size and occurrence as dumb-bells resemble bacterium termo.*

Bacterium termo (Vignal when innoculated in the depths of gelatine produces a funnel-shaped area of liquefaction. The jelly is completely liquefied and coloured green, cultures have a strongly putrefactive odour. They were isolated from human saliva.

(C) A thin non-mobile Bacillus in some examples containing two or four granules, it grows in clumps and corresponds to the Bacillus of Escherich.

N.B. Is this the Bacillus lactis or Bacillus colis communis of Escherich? Escherich found:-
(a) Proteus Vulgaris) Sternberg
(b) Strept Coli Gracilis(p. 668.
Perhaps Dr Klein means the Bacillus lactis aerognes of Eschirich. Escherich believes that this was constantly present in the small intestine of milk fed children.
(See note on Bacillus colis communis of Escherich, Sternberg, p. 670.)

(D) The various forms of micro-cocci differing from one another in size and arrangement: while some formed exquisite chains, others formed more or/

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* See Cruickshanks, p. 541.

or less sarcina-like groups, while still others were in clumps or zoogloea. Of a statement of this kind one can make anything or nothing, at will.

A Report of this character consisting of not more than 13 lines and unsupported by the investigations of any other authority is surely evidence that those responsible for advising the Local Government Board as to the requirements of modern investigation should insist upon reports from more than one Expert upon the specimens they wish examined. This is all the more necessary when one notes the astonishing diversity and semi-comical incongruencies conveyed in the publication of the results separately. One has in studying bacteriological Reports, even on the specific disease which we are investigating too frequently to hesitate in one's own mind whether to be amused or vexed with the totally divergent results of separate investigators. This is doubtless due to the disjointed way in which medical research is at the present time being conducted in this country. There is among investigators a great want of unanimity of purpose or aim, a strange unfamiliarity with each other's methods of research, a lack of some power which would have/

have the effect of inhibiting the energy of enthusiasts and of modifying and directing it into proper channels. There is a felt want referred to in plain language by Professor Michael Foster in his address to the Medical Congress at Rome of something which would harmonise the efforts and interests of investigators. And certainly it seems a poor policy on the part of the Local Government Board of this country to sit down contentedly and fancy they have completed an investigation merely on a report of one man, be he never so able.

Dr Klein expresses no views on the subject of the origin of the greening of stools in Infantile Diarrhoea. He merely mentions the circumstance that the stools submitted to him were green. Perhaps he did not consider it within his province to investigate this matter.

Many views on the subject of the cause of the green colour in the stools have been put forward. It was the green stools which first led the older physiologists to describe this disease as did Rhazes as arising from the corruption of the milk, from bilious humours, and this view held the field till very recently. Writers of the early seventeenth century called the disease not Infantile Diarrhoea, but/

but "A Green Purging with Sour Davour.*

It has been noticed for example, that the administration of mercury tends to produce this greening. Lesage looks upon the Bacillus which he isolated from green stools as the cause of the infectious green Diarrhoea of children. The Bacillus which is isolated from green faeces, and which, when cultivated on artificial plates produced more than one colouring matter, and when it was conveyed to suckling rabbits by means of intravenous or intra-duodenal injections, or by means of food, caused Green Diarrhoea with a very great increase of the bacilli in the bowels. "If we conclude," says Baumgarten, "from the description of the morphology and culture symptoms, the bacillus of the Green Diarrhoea is most likely no other than the well-known saprophyte bacillus fluor, non-liquefaciens, universally known to the German bacteriologist."**

The description of Lesage bacteria in Cruickshank (p. 517) is as follows:-

"Lesage's/

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* See Chapter I., p. 11, where De le Boe Sylvius refers to the greening of the stools from "choler and such like changes of colours as are not unknown to dyers."

** Baumgarten, Mycologie, Vol. II.

"Lesage's Bacillus rods 2.4 micro-metres x 7.5 micro-metres and filaments. Colonis irregular in contour colouring the Gelatine Green on the surface of Agar, they form a greenish growth and the Gelatine is coloured green. Injected intravenously in a rabbit produced diarrhoea. Said to be identical with Bacillus fluor. liquefasciens."

Baumgarten's view of the probability of Lesage's Bacillus being the true cause of greening is thus expressed:-

"Should that really produce Green Diarrhoea, which is not definitely proved by Lesage and which a priori is unlikely, in that case, it would not be proved as a causal agent of the mischief in the intestine, which as the author states assumes in many cases the character of a serious illness which is dangerous to life. The investigations of the author are not sufficient to ascribe this importance to it."*

Our knowledge at present is obviously far from perfect or conclusive as to the specific agent, its description, its life history, its pathogenic action, or/

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* See Green Diarrhoea of Children, Le Bulletin Medicale 1887, Oct. 26.

or the conditions which influence its virulence, but most researchers are of opinion that everything points in the direction of this disease being due to changes produced by bacteria. What the changes are, where they are produced or how they are prefaced, are alike still veiled in the obscurity of the unknown. For future researchers the task is still left of determining more accurately the nature of the micro-organisms and of the toxic products which they can produce.

PLANT ALKALOIDS AFFECTING THE CASEIN OF MILK THROUGH THE MOTHER, THE COW, AND THE ASS, BEARING ON THE THERAPEUTIC ACTION OF SOME OF THE ESSENTIAL OILS, AND OTHER ARTICLES OF DIET AFFECTING THE MOTHER OR NURSE AND CONVEYED TO THE CHILD.

Although this subject is well known to have a bearing on the general nutrition of infancy and childhood, very little that is new has been written about it within recent years. There can be no doubt that substances absorbed from the Intestinal Canal into the blood can be eliminated through the mammary secretion. This subject played an important part in the prescriptions of the ancient writers, who, in their treatment of the diseased conditions of the body, devoted so large a portion of their work to what was known as diet and regimen. Some of these articles were considered as important as drugs, and in the treatment of diseases where Milk formed a part of the routine, they were most careful to select the milk from those Animals which had been fed on Vegetables containing aromatics and sweet smelling stuffs. Thus the Egyptian Mother, in suckling her child, gave the infant through her breast, Lily Oil, Rose Oil, and in some cases fed herself/

herself with Onions and Garlic when she wished to soothe her child and send it to sleep.

In oriental countries, children are soothed through the breast by the Mother partaking of Opium, or other narcotic plants, and in cases where a particular effect was desired through the milk diet derived from various Animals, it was customary for ancient physicians to prescribe the diet, not merely of the patient, but of the animal, the milk of which was to form part of the nourishment. A historical instance of this is recorded of the famous Italian physician, Jerome Cardan, who was sent for from the Hospital at Milan in its bright and palmy days to treat the Scottish Queen (Mary, Queen of Scots) about the end of the 16th Century. At the same time he treated the Archbishop Hamilton, (of St. Andrews), never in robust health, and who was suffering from some pulmonary complaint. Cardan had a prescription for relieving those who "were without breath and those who breathed painfully," which consisted of a form of Beef-juice made of blood serum. Cardan called it "water distilled from the blood of a full grown Pig, and coltsfoot leaves." "Two ounces a day would," he said, "if taken for fifteen days with a little Sugar, fatten a/

a man rapidly, and be found able sometimes to bring back a hectic person from the gates of death." The Doctor mentions the case of Prior Gaddi whom he had cured of a skin disease by employing barley water and chicken broth, flavoured with wine, cinnamon, and ginger; a very nutritious form of gruel, which is even now frequently employed in Scotland, though not for the same purpose. But the most curious part of his treatment provided for "the purging of his brain", for which purpose he directed a mixture of Elaterium with Goat's milk to be sniffed up the Nostril, and for his diet, Milk was the sheet anchor. The Doctor was particular, however, about the kind of milk he employed. Milk increased secretion, kept the stomach open, and in dreamy conditions cleared the brain. The best form for the Archbishop was considered to be asses' milk, and the patient was directed to drink from two to four pints in the morning, either all at once or in several doses with no interval greater than an hour. The ass was also treated, for the quality of the food of the animal modified the quality of the milk supplied to the sick prelate. The donkey, therefore, was ordered to be provided with "mild herbs, such as/

as mallow, juicy beetroots, rose blossoms, as well as fresh corn and barley, and the mother and foal were to run freely in a meadow together daily. The prescription must have afforded satisfaction to this animal thought capable of providing the best nourishment possible for a Scottish Archbishop, whose brother was heir to the throne!

These plant alkaloids doubtless had an effect upon the quality of the milk. There are various plants well known in the Pharmacoepia, which, when taken by the Mother, have their volatile oils excreted through the milk, and thus they enter the infant's body. Some of these are very disagreeable and render milk distasteful, the best example of this class being Asafoetida. If this is taken by the Mother, it will cause the child to refuse the breast. Oil of Onions, as has already been mentioned, had a use in ancient Egypt. This gives unpleasant taste to the milk and at the same time acts as a soporific. The Oils of Dill and Aniseed pass off in the same way,but like the Rose leaves, impart a pleasant flavour to the lactic secretion. If these essential Oils are supplied to the Mother, the child is likely to feed better, and reflexly, the secretion of milk will be stimulated.

These/

These are not the only articles which present themselves in the milk secretion. Iodide of Potassium passes out by the Milk, also Sulphide of Magnesia, and the alkaloid which forms the purgative principle of Castor Oil. Acids, organic and inorganic, pass out freely by the lactic secretion, and cause a considerable amount of irritation in the bowel of the infant, although they may not do so in the case of the mother or nurse who has taken them in the first place.

The question is to consider whether at the period of the year in which epidemic infantile diarrhoea is most common it is not possible that some change in the vegetable materials, or in articles of diet in general use among the population may, under altered conditions of climate, produce some toxic principle, harmless to the more resistent organism of the mother or nurse, but which, when secreted by the mammary glands and taken into delicate organism of the system of the infant, is quite sufficient to act as a virulent toxic poison, setting up all the symptoms of the disease known as Infantile Diarrhoea. The same question may be put in reference to the milk of the Cow or of the other lower animals, whose milk has been used in the artificial/

artificial feeding of infants. It is well known that at certain seasons of the year, the quality of the milk is seriously changed and interfered with according to the food with which the animal is supplied. If the animal, for instance, is fed on Turnips, the milk obtains a turnipy flavour; and if on Linseed Cake, the Oil of Linseed is present in the animal's milk, and it is just possible that in the meadow, at certain seasons of the year, some grass or other plant may be abundant in the animal's food and contain sufficient toxic principle to pass into the milk and do injury to the infant, though the animal itself may be in perfect health. One can only reason in a speculation of this kind from analogy, and these analogies are known throughout the whole of the animal world. Perhaps the best instance of this is to be found in the action of the common Mushroom, and will serve as an illustration of how a small quantity of alkaloidal material ingested into the body may be secreted through the milk gland and act as poisons on the infant organism.

The Mushroom, agaricus muscarius, contains a very active principle, to which Smedieburg gave the name of Muscarine. The peculiar action of this potent/

potent alkaloid has been known through all ages and it was said that when Claudius was poisoned, the poison was formed in a dish of Mushrooms. It was said to act even more potently after it had been passed through a body, or eliminated by the urinary organs. In some parts, notably in Siberia the urinary organs of those who become narcotized by the plant was used as an intoxicating agent by the lower orders. (Schultze's Fetishism, N.Y., 1885, page 52.)

It was said to act like bottled lightning, intoxicating in small doses, and a nerve poison when taken in large quantities. The countenance was said to become flushed; involuntary speech and actions followed, resulting in entire loss of consciousness. It was this knowledge that gave rise to the belief in Scotland, that those who drank of the Borgie Well, as they called it, went "wrang in the head." It was used among the American Indians as a part of their religious worship, and through it they derived the intoxication which was a portion of so many of their festivals. It was worshipped by the Indians, who, as Longfellow says:-

> "Passed to rest beneath the pine branch,
> From whose branches trailed the mosses.
> And whose trunk was coated over
> With the dead man's mocassin leather,
> With the fungus white and yellow."
>
> HIAWATHA.

Taking Muscarine as the most potent of these active principles Smeidieberg has shewn its powerful tendency to paralise the motor nerves and muscles. He traces its power of irritating the peripheral extremities of nerves going to secreting cells or muscular fibres, as for example, the intestine and the heart. It therefore stimulates the saliva, the sweat, the tears, the milk gland, the pancreas, and the liver and intestine. It causes contraction of the involuntary muscular fibres of the pupil, of the bowel, of the bladder, and the spleen, and of the uterus. Instead, however, of increasing the contraction of the heart, it irritates the Vagus so profoundly as to produce a sloughing of its action or a complete stoppage. It interferes with the respiration, produces a cyanosed condition of the face and lips.

Substances perfectly analagous in action to Muscarin may be derived from other products. In fact, the muscarine of the Mushroom can be manufactured, and it has been isolated as a product of decomposition in Fish, and in many laboratory methods.

It is obvious that although our knowledge of the action of the process of disintegration and the formation of new substances within the animal econ-

omy/

omy is so limited, that there exists far more than a possibility of toxic materials being conveyed into the system through animal secretions, quite apart from the method of direct infection from without, or apart from the presence of micro-organism, such as the tubercle bacillus, or the bacillus prodigiosus or bacillus enteritidis.

The animal body can form alkalies - ammonia, for example, - and it need not surprise us to find it forming alkaloids, which is only a question of chemical degree. In health, the action of deleterious products is frustrated and the products are got rid of by elimination. The organic and inorganic elements of life march hand in hand.

It is abnormal physiological processes which produce systematic intoxication, and there is a strong tendency among scientists at the present time to connect diarrhoeic diseases such as Cholera with such intoxication, produced from the elaboration of poisons within the body.

It is towards this class of case that the clinicians have specially directed their observations and to Asiatic cholera more particularly, probably because of its widespread nature, the pronounced virulence of its attacks and the distinctness of its symptoms. The symptoms point to alkaloidal poisoning, although in Asiatic Cholera it is impossible/

impossible in the present state of our knowledge to accurately determine the specific cause. Similarly with Cholera nostras or infantile Diarrhoea. Although theories point in every direction, alkaloidal poisoning from milk secretion is a subject that has not yet received sufficient attention, doubtless on account of its intricacies and difficulties, and on account of the rareness of the qualifications and attainments among medical men required as necessary to the undertaking of the necessary Chemical researches.

It is practically a new branch of study, which is required to give us the measure of Nature's pharmaceutical potentialities in connection with the toxic properties of alkaloids derived from the action of the animal body on vegetable life. In Cholera their action is manifest in the minimised temperature, the algidity of the gastric disturbances which form so marked a feature in the disease. How the alkaloids are produced is not easy to decide, but comparing the main features of Cholera nostras with those more pronounced symptoms of Asiatic Cholera, it is quite certain that they are allied in many points to other forms of toxic poisoning and to one another. Indeed, a morbid series can easily be traced shewing marked similarity/

similarity between simple cases of food poisoning right up to the fearfully fatal disease of Asiatic Cholera, each having an existence of its own, but presenting analogies and bonds of union. It is desirable that more prominence should be given in discussing the etiology of Cholera Infantum, to the fact that vegetable alkaloids can be elaborated before they are ingested and it is no less apparent that they may be still further elaborated by the action of the animal body, increased at certain times of the year, or under certain conditions of the bodily economy with which at present we are unacquainted.

There is abundant proof that such virulent poisons can be eliminated by the glandular structures of the body and passed to the outer world through the ducts of these glands, and in the case of suckling infants it is easy to understand that the products of this biological chemistry may be poured afresh into a new and very delicate organism and thus produce the profound lethal effects with which we are acquainted under the name of Infantile Diarrhoea. It may be that in considering this aspect of research we are reverting to an ancient school of thought, which gave rise to the term/

term "Humoralist", for in considering the action of these alkaloids in a liquid form, it is in reality a consideration of the process of poisoning by a noxious humour, an organic liquid which has undergone the process of deterioration within the body.

The paths of absorption and the action of the large intestine in forming toxic substances will be dealt with in a subsequent Chapter.

CHAPTER VII.

THE ROLE OF THE LARGE INTESTINE.

THE ROLE OF THE LARGE INTESTINE.

One of the most prominent symptoms of Infantile Diarrhoea points to conditions of the bowel and of the faeces which warrant a closer examination of the functions of the lower bowel, and an enquiry as to how the functions of that organ are affected in Summer Cholera. The motions of the patient undergo profoundly marked changes, some of them pointing more or less directly to changes in the Organ. Indeed, the earliest symptom of the disease is a peculiar discharge from the lower bowel, at first yellow in colour and offensive as regards its odour. A peculiar green coloration of the stools has been noted by the very earliest observers, and as the disease progresses it has been observed that the faecal matter becomes more and more diffluent, and yellower in colour, until at length purgation has driven all the remains of food material out of the bowel and nothing has been left to be discharged except serous fluids of the body. In this respect the disease in infants is marvellously like the better known and more deeply investigated Asiatic Cholera.

Before examining the effects of this disease in its relation to the large intestine, it may be well to bear in mind the general anatomy of the organ. It is divided into the ascending and transverse and descending Colon, with the sigmoid flexure, and terminating in the Rectum. The peritoneum is stretched over the front and sides of the ascending and descending colon, but not over its posterior wall, so that the bowel is fixed by these portions of the peritoneum. The transverse colon is completely invested by the ascending layer of the peritoneum, the sigmoid flexure is also completely surrounded, and is attached loosely by a fold of the illiac foscia. The bowel has two muscular layers longitudinal - external, and internal - circular. No part of the tube is destitute of circular fibres though over its dilatations the longitudinal fibres are very sparse. They are, however, aggregated together into three bands called the ligaments of the colon - anterior and posterior and the third placed upon the inner side of the ascending and descending colon and along the lower border of the transverse colon. Along the internal ligament there are certain projections of peritoneum called the appendices epiploicoe. Opposite these ligaments the circular layer of fibres

is absent; they are confined entirely to the position of the sacculi, but are chiefly marked opposite the constriction which separates the sacculi from each other. This gives rise to an eminence or projection of mucous membrane which disappears, however, when the ligaments of the colon are divided. The sub-mucosa and the mucosa are the same as in the stomach and the small intestine; the only glands met with in the large intestine are the solitary glands - simple masses of lymphoid or adenoid tissue, without any collection such as in the small intestine goes to form Peyers patches. There are also the crypts of Lieberkuhn, and many goblet or mucus cells.

The caecum is a projection downwards of the ascending colon where the ilium joins the large intestine. It is situated in the right iliac fossa in contact with the fascia illiaca to which it is united by loose areolar tissue, or by a fold of Peritoneum. About 2½ inches in length, it is closed at the lower end. The contents of the Ilium descend into the caecum, and the muscular fibres by contracting, propel the contents upwards. To prevent regurgitation the ileo-caecal valve is placed here. The vermiform appendix - 3 to six inches long - is directed upwards to the right behind the caecum, and is generally pervious to its lowest end,

which is closed, the upper end being guarded by a valve of mucous membrane. This valve - that is the ileo-caecal valve - is composed of two folds of mucous membrane, triangular in shape, with the pointed end backwards, occupying a horizontal position upon the right wall of the ascending colon - the upper and lower segments respectively - forming a narrow transverse or horizontal fissure or slit. The superior segment is almost more strongly marked and the inferior is somewhat arched or curved downwards - concave along the superior borders. These segments are prolonged along the right and left walls of the colon, forming prominent ridges of Frena. In this there are muscular fibres, the circular propelling the contents upwards. At the same time the fibres in the segments of the valve particularly in the frena or reticula, contract at the very time the food material is passing this opening. They contract in opposite directions and completely obliterate the aperture, thus preventing regurgitation of material into the ilium, although there is not the slightest obstructior to the further passage of material into the caecum and colon. The bend made by the descending colon in passing into the rectum receives the name of the sigmoid flexure. Here the three bands of the long-

itudinal muscular layer spread out and become once more a uniform layer, thus causing the sacculation to disappear. The longitudinal coat ends abruptly at the anus, while the circular develop into a distinct ring, the internal sphincter. The large intestine derives its blood supply from various sources - the caecum and the ascending colon and the transverse colon as far as the splenic flexure, from branches of the superior mesenteric artery; and the ascending colon from the colica dextra; the transverse from the colica media, while the ascending colon is supplied by the colica sinistra - a branch of the inferior mesenteric. The sigmoid flexure is supplied by the sigmoid artery, and the rectum by the superior haemorrhoidal artery. The blood is returned from the rectum sigmoid flexure and descending colon by the inferior mesenteric vein, which pours its blood into the splenic vein near its termination, while the caecum, ascending and transverse colon have their blood returned by the superior mesenteric vein, which together with the splenic vein, unite to form the portal vein, which ramifies through the lobes of the liver.

The function of the large bowel is to receive the contents of the ilium, a diffluent odourless material slightly yellow in colour. The large in-

testine is constantly receptive of materials from the small intestine. Normally this material has an acid reaction due to the presence of organic acids, principally of lactic acid, a product of fermentation. In conditions not far removed from health these contents frequently have their acidity largely increased. This may be due either to a deficiency in the secretion of the alkaline juices of the bowel or to a perverted or additional fermentation producing irritating acids. That this occurs in infantile diarrhoea, even in its earliest stages, is demonstrated by the excoriations which are found in the lower part of the rectum, producing acute pain and occasionally streaks of blood and mucus in the stools, and producing a considerable amount of rawness and even blistering of the skin of the nates. This condition is no doubt developed by micro-organisms acting on the carbo-hydrate materials and tending to arrest at the same time the action of the normal putrefactive bacteria whose work is to convert the diffluent matter into faeces. In the healthy bowel lactic acid is normally present, so are certain bile acids, and a proportion of acetic acid. This in general is held in check by the neutralising power of the normally alkaline juices of the intestine, greater than ever in its alkalinity in the large intestine.

Before considering the character of the material which emerges from the bowel, it may be well to glance at the composition of that which enters the colon. Perhaps it would be rendered more easily comprehensible in the following tabular form:-

(1)	Albuminous matters.	Native albumins	
		Albumoses	
		Peptones	
		insoluble	albuminous / albuminoid materials
(2)	Fats, 85%		
(3)	Carbohydrates and Substances soluble in Alcohol	45%	
(4)	Mineral Matters	8%.	

In the constituents no indol, leucine, or tyrosine is present. They are developed by agencies present in the large intestine. An analysis of the excreta is sufficient to show the tremendous absorbent power residing in the large intestine, and how great a quantity of nutrient material is absorbed from the large intestine. This is all the more noteworthy from the absence of enzymes in the large intestine, as shewing that most of the processes of solution are carried on by fermentative bacteria splitting up the albumens and the carbo-hydrates into

soluble bodies. The large intestine has the power of absorbing soluble albumen without any previous change. This is a fact which is well known from clinical experience. Nutrient enemata consisting of extract of beef, the albuminous bodies of milk, egg albumen, gelatine, peptones, sugars, water, various druga, are easily absorbed by the large intestine, provided always that there are no morbid conditions present and that there has been no irritation in the bowel to inhibit or hinder absorption.

It is a peculiar circumstance that almost every writer on this subject alleges that the onset of this disease is marked by a previous condition of bowel complaint, lasting it may be with intermissions, for a month or even longer, before the virulent symptoms which characterise infantile cholera supervene. Then the symptoms point so urgently to the bowel that the disease has been called by Holt an intestinal toxaemia. Many of the symptoms of a virulent case of infantile cholera are those which are common in most cases of injury to the intestine. Thirst is pronounced and urgent, vomiting is also urgent, anxious and pinched look, the Facies Hippocratica, and a look of impending doom are predominant features. The picture, but for the absence of pain and the presence of profuse

diarrhoea would almost remind one of strangulation of the bowel, or volvulus. I have seen one case in which a bowel had ruptured after strangulation in which the symptoms, fever, thirst, absence of pain, flaccidity of the abdomen, vomiting and the facial appearance almost exactly resemble a case in certain of the stages of infantile cholera. This is mentioned merely to show how profound in a case of summer diarrhoea is the implication of the intestinal canal.

In examining the stools of Infantile Cholera the same method is adopted as in other cases. The odour is minimised by pouring over them in a graduated glass whether liquid or solid a thin layer of ether. After settlement the observer can note the approximate amount of water, mucous and solid matter, the amount of fibrinous exudation, and can also obtain the different constituents of the faeces for examination under the microscope. This will reveal the presence of pus or blood or exuviated epithelium of the mucous and histological elements, and thus an approximate conclusion may be drawn as to the nature and intensity of pathological processes going on in the intestine. Beyond that, the bacteriological growths can be obtained and although the ultimate chemical analysis is still far from complete

or exhaustive, much may be learned from subjecting the faeces to chemical processes.

When examined in this way the stools in Infantile Cholera present many peculiarities even to the naked eye. The stools present a variety of characters in different cases or at different times in the same case. A simple case may be arrested very speedily and pass spontaneously after a severe but temporary diarrhoea lasting from 24 to 48 hours, or by removing the fermenting products from the intestine by increasing the peristalsis. This may be due to the virus having been modified or rendered less virulent, or to a smaller dose having been ingested, or as occurs in many cases of Asiatic Cholera to the organism not having reached its normal point of greatest virulence. This is well indicated in the second set of experiments, Nos.6, 7, 8 and 9, in which the virus obviously contained in the blood serum - as is also the case in Yellow Fever - was modified by passing it through several individuals. The lethal dose of the first developed in 24 hours, producing fatty degeneration. The blood serum of the first passed into the second, took 75 hours to develop, and the 3rd was about the same strength. The fourth modification died on the fourth day; the 5th took seven days. The virus after passing through five indiv-

iduals began to show signs of losing its lethal virulence, and although the diarrhoea was severe, the animal lived by treatment. In 7, 8 and 9 the virus was so modified that the disease was what might be called a slight form - the virus had lost its power.

Even in the typical acute cases the character of the stools varies. The child, generally plump and healthy, suddenly becomes hot, restless, and feverish, and begins to discharge from the bowel profusely, and frequently, a matter which if examined in the manner already described, shows the following general characters. They are described in three sections marking various stages of the disease. In each case the microscopic and bacteriological examination will present great differences, though none are vital to the general argument.

(A) Offensive (most faeces are offensive).

Bilious - In Asiatic Cholera bile is absent.

Solids marked

Liquids plentiful - but not unwarrantably preponderant.

(B) Offensive.

Highly acid in action.

Coloration, Varied. pale green, dark green, chopped Spinach, sorrel. brownish-yellow Greenish brown yellow, like the yolk of an egg.) One of the old names for the complaint was "a green purging with a sour savour."

(C) Odourless

Serous liquid, probably blood serum.

Invariably albumen

Small deposit at bottom of glass (epithelium)

Mucus absent - probably due to the congestion of capillaries: not so marked post mortem.

Blood absent (unless from excoriations)

No formed elements

No flocculent rice water appearances as in Asiatic Cholera.

These are the general representations made by an examination of the faeces of a case of infantile diarrhoea in vitreo, at the various stages of the disorder. They seem to be characteristic, although they do not throw a great deal of light on the causation of the malady. It is to be noted here that when blood or mucus appears in the stools, these are due to effusions from the lowest part of the rectum or from the neighbourhood of the anus, which has been abraded by the copious and unusually strongly acid discharges.

In all cases the amount of soluble albumen in the faecal discharges is always very marked, although the reaction of the stool may be in different cases acid, neutral or alkaline as the case may be.

A remarkable point in the stools of infantile cholera is the Indol reaction which they manifest

as strongly as the stools of Asiatic Cholera. When dilute Sulphuric Acid is added to the stools or the cultures made from them, a red coloration is produced owing to the liberation of nitrous acid from the nitrites which, reacting on the indol present, forms nitrate of nitroso-indol. In order to obtain this action it should be remembered that indol (C_8H_7N) is formed by the organisms of the lower bowel. Nitrous acid with this gives a purple red coloration. The technique for the production of this reaction is as follows:

A watery solution of indol when treated with strong yellow nitric acid, or better still with a 2 per cent. solution of sodium nitrate and pure nitric acid, is either coloured red or furnishes a red precipitate of nitroso-indol $C_{16}H_{13}(NO)N_2HNO_3$ which is very slightly soluble in water, readily soluble in alcohol, and insoluble in ether, and is readily decomposed. If the solution is so dilute as not to yield a precipitate spontaneously, this may be produced by shaking with chloroform, when at the line of junction of the colourless chloroform and the red-coloured liquid a red precipitate becomes visible. If the reaction does not come about quickly, put back in incubator.

The characteristic red coloration which cholera cultures in bouillon exhibit when they are treated with dilute sulphuric acid ("Cholera reaction") depends upon the simultaneous production of indol and nitrous acid by the cholera spirillum (Koch's comma) The nitrous acid is set free by the dilute sulphuric acid and then acts upon the indol, and the red nitroso-indol is then formed, which is identical with cholera-red. 'Vibrio Metschnikoffi' also exhibits the cholera reaction.

A 4% solution of potash nitrate is made and 2 cc. of this is diluted to 100 cc. with aqua distillata. 1 cc. of this dilution is added to every 10 cc. of the culture made from the stool, and after that a few drops of sulphuric acid are added. This produces nitrous acid and gives the reaction with indol. Peptone water or broth may be used. Another method of demonstrating this reaction is by adding nitrate to a culture and then allowing hydrochloric acid to trickle down the tube, and form a layer at bottom. A pink ring indicating indol is formed at the junction of the acid and the liquids.

This reaction is very important although it is obtained with cultures of Cholera Comma bacilli with the Vibrios of Metschnikoff, and with the cultures of the ordinary bacterium Coli Communis. It is at this

point that bacteriology and animal chemistry meet, although chemistry is distinctly weaker than bacteriology in modern investigations, where disease is concerned.

Still it is well ascertained that in the case of external irritants, there are produced in the bowel, irritants which not only act as purgative substances, but as specific poisons to the internal mucous membrane. This is indicated by the great amount of epithelium which is thrown off by the bowel, and by the great amount of pathological transudation from the blood vessels, as evidenced by the amount of albumen held in solution in the liquid dejecta.

But other poisons have been isolated chemically from the dejecta which may throw some light on the causation of Cholera Infantum. Thus from the typhoid bacillus a poisonous base has been isolated by Brieger which produced fatal diarrhoea when injected into Guinea Pigs and Mice, producing a lethargic condition, paralysis, and fatal diarrhoea. It is almost tautological to say that active toxalbumins are produced in cultures of the typhoid bacillus, the characters of which in so many respects resemble those bacteria found in the bacteria excreta of Infantile Cholera.

In cholera cultures Brieger has found in addition

to the non-poisonous - pentamethylendiamin and tetramethylendiamine, the highly poisonous methyl-guanidin besides toxalbumins and globulins, from which researches it appears probable that certain of the gravest symptoms of cholera and infantile diarrhoea are due to actual poisonous action induced by the chemical products which result from the action of the various bacteria and other organisms acting on the albuminous or other materials introduced into the economy.

The question is how are the poisons produced in infantile diarrhoea, and what influence has the large intestine in this production. Whatever may have been the starting point of the disease, sooner or later the condition to be removed is fermentive decomposition due to bacterial multiplication and it is just possible that if the activities of the micro-organisms could be held in check the mucous membrane would soon be restored to its normal tone and habit.

No enzymes have been isolated from the colon just as no ptomaines have been isolated from the small intestine. It has just been thoroughly ascertained that the intestinal juices of the large intestine can only act in the presence of putrefactive bacteria. In a former chapter dealing with the bacteriological origin of infantile diarrhoea the

question has been discussed somewhat generally with a view of grouping modern knowledge on the subject and of indicating the methods of research which have been adopted in regard to the elucidation of this disease.

There are few anaerobic bacteria which do not find in the large intestine something peculiarly favourable for their multiplication, in fact, the composition of the contents of the lower bowel resembles very closely the slightly alkaline peptone broth which is used as the Laboratory medium for growing organisms. The peptone water made faintly alkaline is the best medium for growing cholera germs outside the body.

In the intestine, one finds a normally abundant variety of micro-organisms acting on albuminous material and dissolving it and also on the carbo-hydrate constituents of food. It is in this way that although no enzymes are present in the colon, nevertheless peptones can be formed without their agency by means of the micro-organisms which exist there. These peptones, as has already been pointed out, are quickly absorbed and conveyed to the Liver. The chief micro-organisms present in the normal intestine may be set down as:

Bacillus putrificus Coli (Bienstock) concerned in the decomposition of albuminous substances.

Bacterium Coli Communis (Booker). This organism increases when diarrhoea supervenes in proportion to the severity of the disease.

Bacterium lactis aerogenes (Booker)

1. Streptococcus liquefaciens ilei vel streptococcus Coli gracillis

2. Bac.Bischleri (one of the forms of the Bacterium Coli Communis)

3. Bacillus lactis aerogenes.

These by no means represent the whole of the micro-organisms met with in the normal intestine, but serve to indicate the varieties, the study of which has thrown light on the origin of certain diseases in which the bowel is implicated. The streptococci illustrate how organisms may be modified by growing on different media, and how different effects can be produced from the same organisms due to difference in virulence in one part, and on the other, to a difference in the manner in which they are ingested into the body. The streptococcus liquefaciens coli and other putrefactive bacteria which are the cause of putrefactive fermentation attack the proteids, causing them to produce peptones and other soluble products of putrefactive decomposition of albumen, and this is an important part which they have to play although a small one in connection with the nutrition of the body. Doubtless they have also

an important function to perform in connection with the formation of toxic products. The striking similarity between the bacillus of typhoid and those other bacilli which have been credited with producing powerful irritants in the intestinal canal have already been briefly mentioned, viz., the typhoid bacillus, the bacillus coli communis, and the bacillus interoides. The typhoid bacillus, to give a general description of it, has to be isolated from the spleen. It is from 2 to 3 micromillimetres by .6 micro-millimietre is size: involution forms appear in cultivations; actively motile; stains by ordinary aniline stains; not by Grams; grows well on ordinary media: in Agar thick moist greyish layer; gelatine scanty, white shining, irregular; broth becomes turbid; no film formation; ptoato acid, moist, grey, shining layer; somewhat irregular; Milk, no coagulation, grows well, forms acid; Litmus milk or Litmus sugar, Agar; will grow in slightly acid media; no gas or indol formed; has been isolated from water; oysters (Klein)

The bacillus coli is the normal inhabitant of the digestive tract. It is capable of acquiring an enhanced virulence, and it is present in enormous numbers in infantile diarrhoea, and of a hi heightened virulence.

The following is a description of its morphological and cultural characters:-

Short rods with rounded edges, two or three micro-millimetres long, .4 to .6 broad, frequently united in pairs. Feebly motile. Has lateral flagellae - 2 to 10 in number, no spores. Stains with ordinary aniline stains, e.g. carbol Thionin; decolorised by Gram's. Grows on ordinary culture media. Gelatine streak; copious white shining growth; margins irregular and crenated. In stab culture a white growth along line of inocculation. Gelatine not liquefied. On agar and blood serum a thick moist shining greyish layer. Abundant gas formation in stab culture, and in gelatine cultures of sugar agar and in gelatine streak culture.

On acid potatoes, straw yellow or brown yellow growth. Coagulates milk. Form acid, chiefly lactic, litmus sugar agar, or litmus milk. The gas consists of H and CO_2. Broth gives a general turbidity without film formation. Cultures give the indol reaction on the addition of a nitrate in 24 to 48 hours. Grows freely in slightly acid media and in media containing as much as .15% of carbolic acid; toxic to guinea pigs.

The following are the varieties of Coli:

Lactose & Glucose	.....	Milk	Indol reaction.
Type A	Ferments	Coagulates	None
" B	Ferments	None	reaction
" C	Ferments	None	None
" D.	None	Coagulates	None
" E	None	None	None

All are motile and hace common characteristics:

(1) Typical growth on Potatoes

(2) Small number of flagellae, not more than 8

(3) Develope more rapidly and more profusely than Typhoid Bacillus.

The bacillus coli communis has in the intestine an intense action on sugars. It gives rise to a most energetic fermentation producing ethylic alcohol, acetic acid, etc. It produces organic acids which are neutralised by the alkalinity of the mucous secretion of the colon. It decomposes proteid bodies with the production of skatol, and the evolution of nascent hydrogen, and in this way the colouring matter of normal faeces is produced. All this is distinctly changed in Infantile Diarrhoea. It is a strange and somewhat puzzling fact, as has been pointed out by Gamgee, that the hydrobilirubin, the indol, the skatol, the phenols, which are the results of the putrefactive process which goes on in prepondering measure, if not exclusively, in the large intestine, should in great measure be ab-

sorbed and, after entering the portal blood and making their way through the liver, be excreted somewhat modified, or in new conditions, in the urine. That these bodies play a part in influencing the metabolic processes of the body, scarcely admits of a doubt. The phenols, the indol, even the foetid skatol, which result from the life-work of the putrefactive bacteria of the intestine, illustrate the general law that the products of living organisms are prejudicial to, and capable of destroying organisms of the kind which produced them; for all these bodies are antiseptics of more or less power.

The questions to be solved are what are the factors which cause a perversion of the functions of these organisms, and render them virulent and toxic? as they can undoubtedly become. Dr Klein has described the bacillus interoides sporogenes, a large anthrax-like anerobic gram-staining sporing bacillus. It changes milk in a peculiar manner, precipitates the casein in a kind of foaming mass owing to the production of gas bubbles, and this floats like a raft on the surface of the medium. Below it is a clear strata in which large numbers of organisms are found. This organism has been found to be present in an epidemic of acute diarrhoea, but it is met with in

normal dejecta and is widely distributed in nature, being found in dust, dung, milk and many other places.

So closely are these various forms allied that it is sometimes only possible to differentiate them by the most careful cultural experiments, and by injection into animals. Thus the bacillus interoides sporogenes only differs from the typhoid bacillus in that it ferments glucose. It appears to produce typhoid-like conditions - paracolon conditions which simulate typhoid, but in which the typhoid bacillus is not isolated. It does not give agglutination reaction. This organism is found in certain forms of poisoning, not due to ptomaines, in which you get an incubation period of 24 to 46 hours. In ptomaine poisoning symptoms of nausea are produced rapidly after the ingestion of bad food. But where a living organism is introduced to the food there must be an incubation period, and in the case of the bacillus interoides sporogenes it extends to 36 hours.

In the set of experiments, No.1, in which the blood serum from the index finger of a patient suffering from infantile cholera obtained three hours before death was injected between the spinal column and the shoulder of a Guinea Pig, death was produced in the animal in 24 hours.

Its evacuations were very offensive and the serous dejecta was present in great abundance. In this instance it would appear that some very active ptomaine had been obtained from the blood serum, and that no incubation period was required. But a more striking piece of information was obtained in the case of Guinea Pig No.2, which had not been injected but which had lived in the cage with the injected animal and had in all probability partaken of food contaminated by its excreta. The remarkable thing in this case was the prolonged incubation period, from 48 to 72 hours; almost clearly demonstrating that a living organism had been ingested and not an albuminate alkaloid. It is most important to note the distinction thus demonstrated by these two very important experiments.

In the case of the bacillus coli, although it is normally an inhabitant of the digestive tract, it has also a pathogenic form, and is the main cause of enteritis after strangulation and ischio-rectal abscess, and it may be under certain conditions of temperature, or as Henoch alleges, of fermentative disorders in children, or a combination of these circumstances, that the bacillus of the colon may attain a virulent pathogenic power, which is absent in its normal condition.

To illustrate the closeness of resemblance between this group of organisms the following table may be of some interest:-

DIFFERENTIAL TABLE

between

	TYPHOID	ENTEROIDES	COLI COMMUNE.
1. Morphology	Well marked rod, 5 or 6 as long as broad.	Rod 5 or 6 times as long as broad	Shorter rod 3 times as long as broad. Often oval.
2. Flagella	Long and wavy. 20-30 usually 8-12	3 or 4	Shorter, 2-10. Usually 3 or 4.
3. Motility	Very active	Less motile	Slower, feebly motile.
4. Colonies on gelatine plates at 22° Cent.	Small, roundish, granular. Brown by transmitted light	Limited growth	Round or oval, brown in colour. Crenated margins larger growths than Typhoid.
5. Gelatine culture 22° Cent.	Grey-white, growth small, and almost confined to middle track.	Ditto.	Greyish-white, spreads crenated edges, medium, cloudy near growth.
6. Gelatine streak culture.	No gas	No gas.	Many gas bubbles.
7. Stab Sugar Agar cultures	No gas	No gas	Many gas bubbles
8. Acid potato	Greyish thin invisible film	Invisible	Straw coloured, yellowish brown, thick shingin growth.
9. Milk	No coagulation	No change	Curdles in 1 to 3 days.

	TYPHOID	ENTEROIDES	COLI COMMUNIS.
10. Broth	General turbidity; no film formation	General turbidity	General turbidity; no film.
11. Indol reaction	None	None	In 24 to 48 hours.
12. Broth with 30% Phenol or Formalin 1 in 7,000	No growth	No growth	Grows well.
13. Acid production.	Some	Some	Much
14. Glucose	No change	Ferments	Ferments
15. Lactose	No change	Ferments	Ferments
16. Agglutination	Present	Absent	Absent.
17. Liquefaction of Gelatine	None	None	None.
18. Diazo reaction.	Present	Absent	Absent.

Another group of organisms consists of the spirillae, cylindrical cells more or less wavy, consisting of two types, first a spiral thread or spirillum, and second, a short curved rod or comma, have been accredited as giving rise to this disease. The spirillum for example, of Finkler & Prior, has been isolated in cases of Cholera Nostras. It is a short thick curved or straight rod without spore formation, and decolorised by Gram's stain. Morphologically, it is like Koch's

bacillus of Cholera but culturally it liquefies gelatine much more rapidly. A stab culture in gelatine of the two presents a marked contrast in the test tube.

The Spirillum of Finkler & Prior has a yellow growth produces rapid liquefaction of the medium, and on Agar produces a slight brown moist layer.

One can only remark on the similarity of the organism and the similarity of the symptoms, for there is no data upon which any judgment can be formed as to the exact influence of the spirillae producing epidemic diarrhoea or infantile cholera.

One point, however, should not be overlooked, namely, what is known as the symbiotic effects of these bacteria. For instance, if you take a streptococcus that has lost its virulence, and inject along with it the Coli Communis you will increase and renew its virulence by what is called symbiotic action, and their power of increasing the toxins seems to be greatly enhanced by their connection. These toxins may be either pure toxin or degenerated albuminoids allied to ptomaine. Any condition which

lowers the vitality will greatly increase the virulence of adventitious organisms. This is a point worth thinking of in connection with epidemics of Cholera Infantum.

Many post mortem examinations have been made on cases of Cholera Infantum, and the large intestine has been carefully examined with but little result. Klein has observed the peeling of the epithelium of the bowel in these cases, and some other investigators have reported an abnormal pallor of the whole of the mucous membrane of the digestive tract, with slight enlargement of the solitary gland. These never go on to suppuration or to profound inflammation as is the case in Typhoid Fever. It greatly resembles in its effect upon the intestine what is met with in tropical conditions known as "Sprue", where a peeling and thinning and loss of function of the mucous membrane are so marked, but in which there is no profound diarrhoea, but merely fermenting stools.

The absence of abdominal pain is in one sense sufficient indication that no great injury has been done to the bowel by inflammation, and it may be on the other hand an indication of some intestinal narcosis or paralysis, that has been induced by the poison whatever it may be. All observers are

agreed that the mucous membrane is vascular, due to the determination of the blood to the mucosa and to the consequent exudation of serum into the bowel - exactly what occurs in Cholera Asiatica. With this there is a cessation of absorption and at first an excess of mucus which, however, ceases when the mucous and submucous coats of the intestine become bared and swollen. Some writers speak of an infiltrated false membrane in which an amount of yellow gelatinous lymph or semi-purulent fluid is found beneath the mucous coat of the large intestine (Goodhart); and others mention some superficial ulcers of the bowel, as well as enlarged glands. A carefully prepared section of the gut shews that it is infiltrated in the sub-mucosal layer with a considerable amount of round cells similar in appearance to what one gets in Meningitis and other inflammatory troubles of a septic nature.

One of the most important experiments is that which demonstrates in guinea pigs the virulence of the blood serum of cases of Infantile Diarrhoea. It is a new idea and if substantiated would tend to prove a general infection rather than an infection coming from a localised source. It is all the more important as recent researches have demonstrated a similar effect in human beings by inoculating the

blood serum of yellow fever. The poison was found to exist in the liquor sanguinis, in this respect differing from malarial blood, in which the organism resided in the red blood corpuscles. The American commission appointed to investigate yellow fever filtered the blood of a yellow-fever patient and injected the serum much in the same way as was done by the operator in experiment No.1, and they succeeded in conferring the disease. This demonstrates that the parasite resides in the blood and although it has not been detected by microscopical examination it may be that the parasite of Infantile Diarrhoea, supposing the cause of the disease to be an organism, may be so small as to be beyond the power of microscopic observation - ultra-microscopic. But, as experiments have shewn, - as in the case of Guinea Pig No.2 - one cannot afford to ignore the fact that the poison may be ingested by the food, that it may be organic, and passed through the bowel with the faeces and that its ingestion is followed by an incubation period of from 2 to 3 days, in this respect differing entirely from the fomites of Yellow Fever.

Chapter 8.

A CONSIDERATION OF THE SYMPTOMS AND CLINICAL FEATURES OF INFANTILE DIARRHOEA.

A CONSIDERATION OF THE SYMPTOMS AND CLINICAL FEATURES OF INFANTILE DIARRHOEA.

There are many aspects of cases of Infantile Diarrhoea which demand a careful scrutiny alike by the investigator and by the clinician. Infantile Cholera is a disease which is very apt to be mistaken for ordinary catarrhal diarrhoea, and other diarrhoeal affections, and indeed this mistake appears very often in the Registrar's statistics. This point has been dealt with generally in a previous chapter, but it is in relation to symtomatology that most stress has to be laid on it. This is all the more important as it is usual that a Choleraic outbreak may be preceded by or run concurrent with outbreaks of ordinary diarrhoea. Too much stress cannot be laid on such a point, especially in the early days of an outbreak, or in these abortive or mild cases, which careful observers have noted and which may be of the greatest importance etiologically.

Symptoms resembling true cholera may supervene in the course of an ordinary severe diarrhoea, and are very usual in cholera infantum, in mushroom poisoning, in ptomaine poisoning, in the early stages of trichinosis, and in a certain type of pernicious

malaria. In early cases the diagnosis may not be so easy, unless the stools are carefully examined. In the simple, abortive or mild cases it is not easy to draw the line of demarcation too stringently or to paint the clinical picture presented by the symptoms so as to differentiate sharply this cholera infantum from other abdominal troubles in which catarrh forms a feature, and which, in the case of Infants, is rendered very much more complicated.

The infantile form is said to be identical in its clinical aspect with choleraic diarrhoea in the adult, and according to Emmet Holt it occurs only in two or three per cent of all the cases of Summer Diarrhoea. It is therefore highly important both in the interests of statistics and of treatment that errors in symptomatology be not permitted to arise.

Both the clinical and pathological features of Cholera Nostras in young children are extremely like those of acute dyspepsia in infants. In both cases we find very varying degrees of severity, from a more or less profuse diarrhoea, to the most severe, and rapidly fatal Cholera Infantum. The first symptom in these mild cases = and one never knows when they are going to become pernicious - is the occurrence of loose motions which are to begin with of a brownish-yellow or greenish colour, and which

rapidly succeed one another. Either there is no pain whatever in those cases, or it is so slight that even older children scarcely complain of it. Apart from anorexia and great thirst, the general health may remain good, and with careful nursing the diarrhoea passes off either spontaneously or as the result of proper treatment after 24-48 hours, as soon as the fermenting contents of the intestine have been removed from the body by increased peristalsis. That, at least, is the view of Dr E. Henoch in the University of Berlin.

The symptoms may be referable to seasonal influences occurring in different localities, at different times, but in this respect cholera infantum is not singular. This was pointed out long ago by William Cullen who regarded it as "A convulsive disorder peculiar to certain climates and persons, occurring most commonly in summer, whenever the summer heat first sets in". This, he says, is a singular circumstance and must arise from "some particular affection of heat in our bodies, whether in increasing the quantity of the bile or increasing its acrimony is not certain - most likely the latter." It is an interesting old-world cautious way of putting the case, which we may have occasion to allude to again. This is the view which Meinhart has adopted with modern modifications.

In a typical and well marked case the primary symptoms are referable chiefly to that Holt calls the toxic factors - "The effect of a poison on the heart, nerve centres, and the coats of the intestine." They are symptoms of "Acute inanition and intestional toxaemia." In this respect the healthy conditions of the children attacked forms a striking factor of proof. It used to be alleged that breast fed children had a kind of immunity, but Ballard's statistics point out 42% of deaths among healthy children, leading him to state that his experience did not support the opinion that Cholera Infantum makes its first fatal swoop upon the weakliest children.* Ballard estimated that out of every 75 children, 26 of those who died were not weakly. This makes the symptoms of toxicity all the more valuable.**

The sudden development of the symptoms is another characteristic feature of the disease, not as a special series as Henoch mentions, but as a constant factor accompanied with more or less violent phenomena. All authors have laid stress on this aspect of the symptomatology. Holt lays stress on the on the presence of some antecedent intestinal disorder, Diarrhoea, or Ileo-colitis, and inists on the close connection between feeding and impure Cows milk as being

* Loc. Gov. Board, pp.43-45.
** Emmet Holt places the deaths among breast-fed children as low as 3%, but he says (p.382) 'Healthy infants are attacked.'

well established. There is something present in this disorder more than an excessive intestinal catarrh proceeding from enteritis, caused by continuous ingestion in doses sufficient to determine a vicious alimentation out of harmony with the appetites of the individual. The influence of season by putting its stamp upon it makes the enteritis a special enteritis of a character so malignant as to often baffle all therapeutic efforts.

At first, in the well marked cases, the symptoms during the stage of onset are chiefly referable to the alimentary tract, incessant purging and vomiting, but mostly unaccompanied by any pain of a pronounced nature. The emesis is constant and urgent, and begins at once if the case is severe, and excited instantly by any attempt on the part of the little patient to take food or fluid, and any attempt to control it it met with marked failure. The stools are frequent, and at first febrile in character, sometimes pale green, sometimes dark green like chopped spinach or wood sorrel, at other times in the disease they are purely bilious bright yellow, or like the yolk of an egg, with an acid neutral, and passing into an alkaline reaction. The acid reaction sometimes gives rise to cracks and excoriations round the anus, and to erythema and erosion of the skin of the buttock.

The child cries (a distant brassy moan) and sometimes draws up its legs. (Cheedle). The stools never have the appearance of rice water stools, but pass on into pure blood serum in no way depending upon the ingesta, but apparently on the state of the various excretions into the Alimentary Canal.

It is the violent symptoms marking the onset of this disease that make one ask "Are such initiating phenomena the result of toxins acting immediately and directly on the central nervous system, or whether they are merely indications of nature's usual method of setting up irritation of the bowel in order to prevent absorption of poisonous materials and by increasing peristalsis to remove the poisonous materials by which the profound symptoms of the disease are produced? Probably the correct answer is that both these factors are at work but obviously the central nervous system is later in being brought under the influence of the toxic products, than are the distal or terminal ends of the pneumogastric or sympathetic systems which control the gastric areas, which are supplied by the epigastric plexuses, and only indirectly connected with the central nervous system.

In this way we account for the early appearance of the abdominal symptoms and for the comparatively late onset of those proceeding from the central sys-

tem such as the implication of the circulation, respiration, the motor and sensory symptoms, and that series of symptoms which has lead recent writers to speak of the later stages of the disease as "Spurious Hydrocephalus", a term made use of originally by Dr Marshall Hall in this country. The other symptoms indicative of general implication of the digestive tract, are seen in the tongue, which is red and furred, the abdomen becomes more or less flaccid, shrunken and shrivelled. The skin soon loses its elasticity, and if pinched up tends to retain the marks of the fingers for several minutes, and not to unfold itself. This want of tonicity soon comes on in the young infant and becomes general, and gives a peculiar expression to the face, and as the case lasts the skin and subcutaneous tissues become hard and firm towards the fatal termination; the appearance has been compared to a half frozen cadaver. It is not often in choleraic diseases that tympanitis is met with. It sometimes occurs in this disease even in its stages of onset as a very unfavourable symptom leading to imminent collapse. This tympanitis, when it occurs in Typhoid, is said to be due to the milk in the intestine undergoing gaseous decomposition. Distension of the abdomen is likewise

said to be due to ulceration of the bowel, but in Cholera Infantum the changes which result in ulceration are not marked in post-mortem inspection. Allthrough, the case is marked with an urgent desire for fluids. The child is constantly raising its head for fluids prior to the onset of the stage of exhaustion, and the endeavours to relieve the desire seem to merely aggravate the condition. Prostration of a very pronounced type is conspicuous from the onset of the disease, and it is accompanied by a rise in the temperature of a singular character, and the pulse becomes very rapid.

For purposes of description the second stage, or hot stage, is now marked by a rise in temperature varying greatly in proportion to the severity of the attack, and which if it should remain high may be taken as a very unfavourable sign. It is not unusual to find temperatures of 102° or 103° Fahr., in cases where recovery takes place, provided it falls in the course of a few days. A temperature of 104°-105°Fahr. is usually fatal, and in cases of severe implication of the central nervous system, it not uncommonly runs up to 106° and 108°. (See Chart). The axillary temperature may register three or more degrees below that of the rectum, indicating profound failure of the peripheral circu-

lation, and implication of the cutaneous vasomotor centres. Many of the compound ammonias have this action, and it is curious to note in regard to their effect, that before total paralysis sets in a condition of great wekaness, languor, and depression is felt almost similar to that seen in the onset, and throughout the whole progress of Infantile Cholera. Brunton points out that "from the decomposition of albumen in the intestines, a great many poisons are formed, some of which belong to the series of compound ammonias. Probably it is some of these which by exercising a paralysing action on motor nerve endings, give rise to the weakness and languor so often associated with indigestion and which can be frequently removed by simply sweeping out the intestine and clearing it of the decomposing products it contains.

In this disease, therefore, one does not wonder at finding the surface temperature rapidly sinking to 99°Fahr., and rapidly even as low as 95, a condition of complete collapse threatening immediate dissolution of the patient from exhaustion.

Trousseau mentions that with the ascending rapidity of the pulse the temperature continues to fall, the extremities, the nose, and chin become cold as in Asiatic Cholera, but at first the cyanosis

is not so much marked, and the sweat - if there is any - is never viscid, as in Asiatic Cholera. The skin remains dry and of an ashy paleness, and the exhaustion and weakness become more and more profound [illegible], due in a great measure to the drain on the system, so pronounced that Willis in 1670 spoke thus of it:- "If an equal quantity of pure blood had been discharged, it could not have produced equal weakness" This is quite consistent with what we have just mentioned regarding the action of ammoniated toxins in producing muscular prostration similar to that brought about by Curara. An important point, however, is the great and sudden loss of substance which occurs in the disease. Holt puts it at 3 lbs. in two days. This is evident to the onlooker who notes the coldness and loss of tonicity of the skin, the sunken and receding eyeballs, and loss of tonicity of the orbicular muscles, with the blue line encircling the lower eyelids, and the bluish coloration under the nails. This presents the very typical aspect or facies of Cholera Nostras.

If the blood be examined, the corpuscles will be found to be greatly diminished and shrunken, very deficient in Haemoglobin, and the blood vessels will be found to be almost half empty. The countenance has therefore a leaden hue, and the features are

drawn and almost obliterated. Death may occur at the end of the second stage. The Symptomatology may be summed up, in Henoch's words, "Occasionally the attack begins with a very high fever, as in infectious diseases, while more generally we find only a slight rise of temperature, if any. Profuse watery motions and vomiting rapidly succeed each other. The severity of the latter varies greatly; it sometimes takes place only at long intervals, sometimes very frequently, every time fluid is taken; and there are even cases in which vomiting is the chief symptom, and in which only a very few motions occur in the course of a day. The rapid failure of strength, however, is common to all; and it is more rapid and more severe the younger the patient is. We find it, however, in older children, and even in adults. Great lassitude, pallor of the skin, sinking of the eyes into their orbits, coldness of the cheeks, hands and feet, increasing rapidity and smallness of pulse, weak and almost inaudible voice, slight cyanosis of face and mucous membrane, all indicate failure of the heart's energy.

The patient may die during the acute or hot stages, though a proportion of cases, as has been pointed out in a former Chapter, recover. The violent symptoms subside gradually and the recovery

is slow and protracted, frequently resulting in Chronic Diarrhoea, vomiting, Catarrh or peritonitis, In other cases death occurs from exhaustion and sudden collapse, or else the patient passes into the third stage, the cold stage or stage of exhaustion in which are found spasms, twitchings, and other indications or cerebral irritation. Vomiting which may have ceased, seems to recur, the diarrhoea - so prominent a symptom in the early stages - seems to stop and then follows distension of the abdomen, probably due to sheer exhaustion of the bowel. A notable elevation of the temperature succeeds the preliminary low temperature, and the skin appears to regain its tomicity as if the effect of some lethal poison had suddenly been lifted from the sufferer. The tomgue is red and dry, almost like roasted leather, the pulse soft, compressible and rapid, and the cardiac sounds, especially the first, are weak, and the eyes injected. This is the typhoid state. It has been the custom to refer this state to the action of the fever poison on the brain directly. The difficulty id that the symptoms in advanced stages of so many fevers are so much alike that it can hardly be attributed to the specific poison of the individual disease itself. Some refer it to the increased temperature; internal, as Liebermeister; or external, as Meinhart

and the recent view in many cases is that the prominent cerebral symptoms are caused by specific embolisms or plugging of the cerebral capillaries with organisms. This can be demonstrated very clearly in the case of malarial hyperpyrexia where the patient has cerebral symptoms and dies in a comatose condition.*

The same symptoms occur in what are called the Gastric and Choleraic forms of Malaira. Of these Manson says, "In the Gastric or Choleraic forms, there is probably an accumulation of plasmodia in the vessels of the intestinal mucosa." (Page 77). Another view to take is that the cerebral symptoms are caused by the retention in the system of effete products generated in the conflagration and which poison the whole vital fluids.

The effect of the failing circulation is manifested by the breathing which at first hurried, soon becomes irregular and develops certain peculiarities not necessarily arising from any local mischief in the lung, but from general implication. The ratio between each respiration is at first equal, though rapid, say 46 per minute. In later stages we get an increase in the ratio, the breathing partaking more of the character of a sigh.

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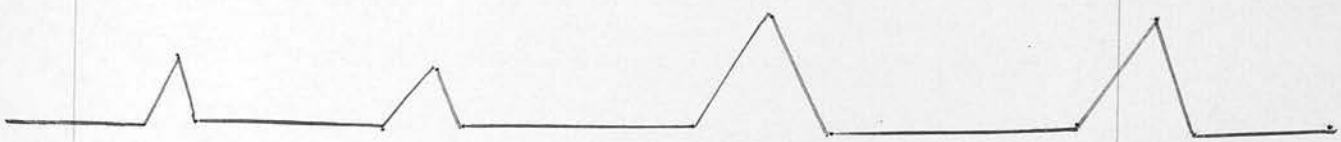
* See Manson. "Tropical Diseases", pp.76-77.

I.

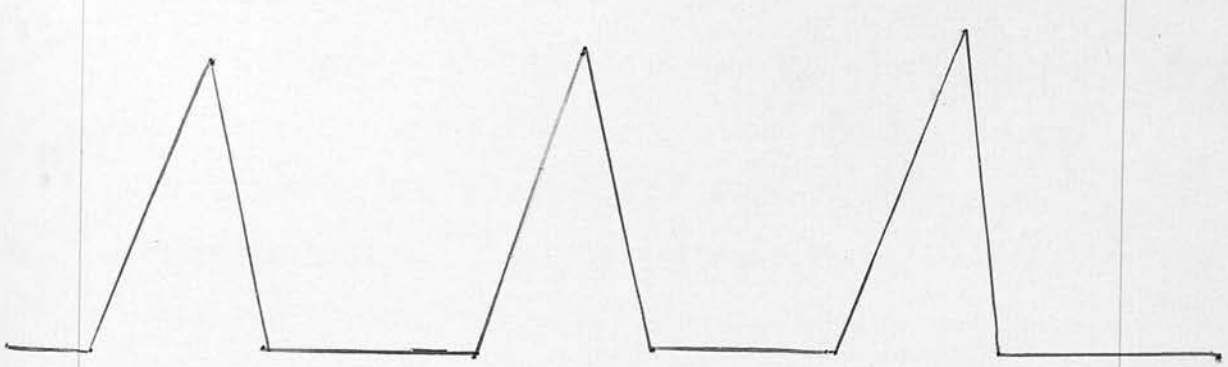
Rapid, but equal.

II.



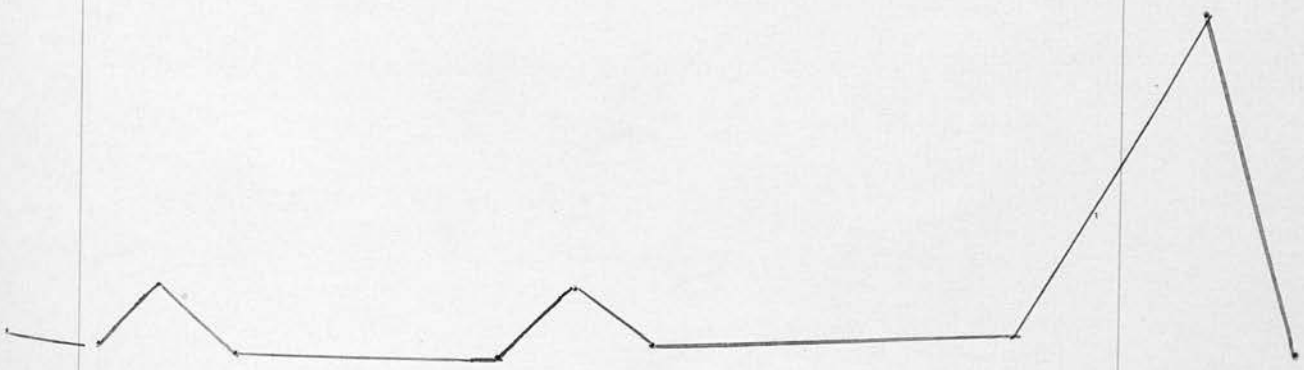
Ratio increased.

III.



Ratio increased, inspiration deeper.

IV.



Great increase of ratio - with sigh.

The breath becomes cold as in Asiatic Cholera from the extreme loss of Metabolism.

In this respect Cholera Infantum closely resembles Cholera Asiatica. When the vomiting stops the stools reappear, bilious in colour, something as in Epidemic Dysentery, glairy and sanguinolent, and often of a purulent appearance. Stupor supervenes combined with congested up-turned eyeballs resembling in expression cerebral fever, both in aspect and in the plaintive cry of the little patient - a cry of suffocation. The disease resembles meningitis in the restlessness and jactation of the onset gradually passing into a state of drowsy apathy; in the alteration of the pitch of the voice, distant and almost inaudible. Thirst is insatiable, the pulse rapid and feeble, becoming towards the end irregular and imperceptible. Before the termination diarrhoea may cease. There may be convulsions, the head may be retracted, as in cerebro-spinal meningitis and the respirations incompetent and irregular, and sometimes - though some observers deny it - it assumes a Cheyne Stokes type. These symptoms have been already alluded to as Marshall Hall's "Spurious Hydrocephalus", but in Infantile Cholera no changes in the Meninges or Brain Structure have been found, and Osler, (page 393) thinks the condition is no

doubt caused by the toxic agents absorbed from the intestines.

A very important point symptomatically is the pronounced suppression of Urine which occurs in an early stage of the disease and the large amount of Albumen which is present. This is doubtless due to a profound organic change which has implicated the kidney. The kidney is found to be in a state of fatty degeneration, pale in colour, yellowish in tint, and in section under the microscope there is a parenchymatous nephritis. This condition seems to be established early in the disease, probably within a few hours of the onset well marked albuminuria appears. The cells of the liver also are found in a high degree of fatty degeneration. This is very significant of poisoning by some organic virus and has been demonstrated on animals.*

We have not yet mentioned some points upon which Henoch lays some stress, important more from a pathological than from a clinical standpoint. While mentioning the fury with which the disease works in Germany in decimating the population of large towns and indicating that the immediate cause of death is rapid exhaustion with collapse, and hydrocephalic symptoms - he points to the depression of the open fontanelle, with displacement of the frontal and

* Experiments, Set I.

occipital bones. He continues, "I have nearly always found the leashes of enlarged conjunctival vessels and little fragments of mucus on the surface of the conjunctiva with dimming of portions of the cornea, especially that portion of it which is not covered by the half closed lids." He regards this sign, found also in meningitis, as almost a fatal one during the stage of collapse. "I have often seen the hydrocephaloid condition go on developing to the end in spite of the fact that neither the vomiting nor the purging were by any means very severe, or might even both have entirely ceased. In some of these cases delusive hopes had been aroused by the temporary return of warmth and improvement of the pulse, due to the administration of stimulants.

The following notes of cases will show the general course of the disease, which varies in every individual:-

CASE I. A plump healthy child suddenly becomes hot, restless and peevish: gets thirsty: perspires, vomits and purges. Called in June. The child vomited yesterday but had 8 motions very watery and highly offensive in odour.

Next day; eyes sunken with darkened areola; bowels loose; abdomen flaccid, and the peculiar facies abdominalis; gurgling sound all over the abdomen.

A consideration of the symptoms enable one at a glance to see why the term Cholera should have been applied to this form of Diarrhoea in young infants. The relations between the two may be tabulated thus:

CHOLERA ASIATICA	CHOLERA INFANTUM (English)
Onset:	Onset:
(a) Attacks adults and persons of any age.	Attacks the young.
(b) Without prodromata (sudden)	Without prodromata (sudden)
(c) May supervene on Diarrhoea	May supervene on Diarrhoea.
(d) Resisting power of Mucus Membrane may be impaired by a previous Catarrhal Condition.	Catarrh may cause lessened resistence.
Stools:	Stools:
Profuse, watery, neutral, at first faecal, then colourless, then rice water. Flocculi of epithelium. Contains Koch's Comma Bacillus. Large quantity of Salts, notably Sodium Chloride.	Profuse, watery, faecal, green, then serous without flocculi. Contains Bacilli Communis Coli, etc.
Vomiting:	Vomiting:
Abundant: first food, then rice water - accompanied with great sense of sinking in the Epigastrium.	Abundant, frequent, food, bile then serous.
Cramp:	Cramp:
In abdomen and limbs, sometimes calves of the legs, arms or chests strong enough to rupture muscles, and frightfully severe.	Absent, painless generally.

CHOLERA ASIATICA	CHOLERA INFANTUM (English)
Skin: Shrinks and shrivels, viscid sweat, gets blue	Skin: No sweat, dry, shrinks, shrivels wasting.
Thirst: Insufferable	Thirst: Urgent.
Muscles: Waste.	Muscles: Waste.
Eyes: Sunken.	Eyes: Sunken, with wasting of orbital fat.
Voice: Vox Cholerica - hoarse whisper. Feeble, husky, hollow.	Voice: Brassy, distant, moaning.
Urine and Bile: Greatly diminished or even suspended.	Urine and Bile: Suppressed.
Temperature: External, 100°F., 95 or 93 collapse. Rectal, 103°F. 106 collapse, burning. The low temperature is accompanied with profuse sweat all over the body.	Temperature: About the same.
Pulse: Thready, and weak, gradually imperceptible, or abolished in the peripheral arteries.	Pulse: Rapid, imperceptible.

CHOLERA ASIATICA.	CHOLERA INFANTUM (English)
Respiration: Shallow and slow; irregular. Cheyne-Stokes, cold breath.	Respiration: Seldom Cheyne-Stokes, cold breath.
Nervous Symptoms: Restlessness, intense thirst, Cramp, sleepless, apathetic, Patient sensible and usually callous to his fate. Coma.	Nervous Symptoms: The same, except no cramp. Loss of sleep and rapid exhaustion.
Death: Rapid, in 2 to 30 hours. Usually in 10 to 12.	Death: In 24 to 48 hours, but may be much earlier, in 4 to 8 hours.
Pathology: Tissues dry, fibrin clots, lungs anaemic, peritoneum dry, bowel injected with ecchymotic spots. Peyers patches and solitary glands congested. Kidney congested, tubules granular, epithelium cloudy, granular or fatty.	Pathology: Tissues dry, skin thickened and hard. Cadaverous-like bowel; thickening and infiltration of mucous membrane with round cells Softening and occasionally small superficial ulcers, rarely of follicles. Abnormal pallor of bowel, glands enlarged. Atelactasis of lung tissue, collapsed lung. Kidney, cloudy swelling. Liver, fatty degeneration.
Nervous System: Brain anaemic, no gross lesions. Koch's Bacillus abundant and virulent.	Nervous System: Nothing special. Bacillus Coli Communis, etc.

In the collapse stage and hydrocephaloid condition there are certain symptoms by which the disease can be recognised alone. Not only the cadaverous pallor, cyanosis and constant drowsiness which precede the final stage of complete coma, with depression of the fontanelle and displacement of the occipital bones, but by the condition of the eyes. The dark shade round the lower lids is especially marked. The eyeballs sink in their sockets (enophthalmos) during the typhoidal stage. The winking of the eyelids becomes abolished and the lower lid drops leaving the extreme lower part of the cornea exposed giving rise to Xerotic Chòroiditis, resulting in retinal inflammation. This is probably caused by the venous congestion of the eyelids from cardiac debility. Small fragments or threads of mucus gather on the surface of the conjunctiva and on the cornea, giving it a dim appearance, a sign which has almost always been regarded as fatal. The pupils are contracted and give no reaction to light. It sometimes happens that even with these signs recovery takes place. Henoch mentions two cases. In one he says, "The patient was in a state of collapse and the lower halves of both cornea (which were not covered by the half-closed lids) were dim, as if sprinkled with dust. By the next day (when the

collapse had ceased, and the eyelids were completely closed) the cornea had completely recovered their normal lustre."

If the patient is going to recover after the deeper or more or less algide stage, a reaction may set in - a refreshing sleep may be the indication. The patient gets restless again; cardiac action becomes vigorous, the pulse returns, the skin looks less deadly, the urinary secretion is re-established, though it may be in small quantities, albuminous, sometimes containing blood and tube-casts and only a very small quantity of urea. This recovery stage is not devoid of danger from inflammatory conditions resulting in the internal organs. Congestion has to be borne in mind. This stage may be prolonged indefinitely, and after it is re-established the patient may again lapse into the algide condition and die from suppression of the secretions.

The whole picture from first to last is one of extreme gravity, except in very mild cases.

We have discussed its mortality, and the different aspects it may assume. A large proportion of severe cases die. In this country the mortality varies very much with the external temperature in a way not easy to understand. Outbreaks in this

country do not appear until the Earth's temperature goes up beyond a fixed point, and when the outbreak arrives it seriously taxes the medical man who has to deal with the individual cases no less than the epidemiologist who views the disease from a different if quite as obscure a point of view.

CHAPTER IX.

TREATMENT OF CHOLERA INFANTUM

OR

I N F A N T I L E D I A R R H O E A .

Its General History, and its recent Developments.

TREATMENT OF CHOLERA INFANTUM

or

INFANTILE DIARRHOEA.

Its General History, and its recent Developments.

The widespread and dangerous nature of this disease among infants and young children during the Summer months in this latitude, the rapidity with which it supervenes and carries off the individual, together with the usually fatal nature in severe cases, and its liability to assume epidemic proportions, accounts for the large number of methods of treatment with which it has been attempted to deal with Cholera Infantum. Centuries ago, the proper treatment of the trouble was a bone of contention among rival professors as much as is the case now. One of the very earliest Egyptian remedies was a mixture of onions and boiled sour milk, boiled blood used as astringents, but of an animal nature. A good deal may be said at the present day for both these remedies in Infantile Diarrhoea. The gizzards of animals fulfilled in ancient times the role of the/

of the modern pepsins and ingluvins. The discussion as to whether elimination or astringent treatment should be adopted raged in the time of Rhazes (832-923 A.D.), who held to the view now adopted by many of our present-day authorities, "If the belly be lax give nothing laxative for anything that increases the discharge is not safe." He held to the bland, thirst-assuaging "barley gruel boiled in Pomegranate seeds with a little gum arabic and sugar." Sydenham's view that the Cholera morbus of infants was due to overfeeding or teething as well as his treatment by Laudanum, has been replaced by fuller knowledge of the condition of the internal organs and of the causation. The old English practitioners of the 17th Century insisted on treating the disease as arising from "corruption of the milk or nourishment as giving rise to excrements yellow or green, also stinking." A favourite remedy was the yolk of egg roasted with carminative and astringent seeds, made into a powder and combined with half a grain of white poppy. Wine baths and bread poultices were used to determine the circulation towards the periphery. While administering this the milk was stopped "lest it curdle in the stomach". The Laudanum treatment

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was recommended by Silvius who also used Clysters of Cow's milk, yolk of egg and Venice turpentine.

Benjamin Rush was probably the first to describe completely what is now called and was indeed named by him Infantile Cholera, or Cholera Infantum. He laid stress on the treatment by evacuation of "the belly and stomach", by tartar emetic and Ipecacuanah, - for violent diarrhoea, a few drops of Laudanum and plenty of demulcent drinks, plasters and cordials and baths, and he even recommended as a prophylaxis, teaspoonfuls of good old wine to be administered to the infants. This probably acted as an intestinal antiseptic. A curious old form of treatment which has recently come into modern use for the treatment of Infantile Diarrhoea with green stools, is the acid treatment. The older authors could only administer Lactic Acid by the medium of sour milk. The Arabs called it "Kefir" and were accustomed* to give draughts of this with a little rusk soaked in it, and some gum arabic. It is now recommended again for this complaint in the following mixture to be given every two hours or more frequently if necessary:-

Lactic acid ..... 1 to 2 parts.
Syrup of Orange Flowers, 30 parts.
Distilled water ..... 70 parts. *

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* Revue Critique de Medecinet de Chirurgie, 1902.

In the treatment of the ancient doctors, we certainly see the shadow of our modern rationale, but very dimly and distantly. Not until the time of Rush was the epidemiological nature of the malady recognised or treated. He was careful to state that removal of the children from the seat of infection was a valuable measure, as well as the attention to the clothing of the child. The importance attached to this aspect by modern physicians has led to the appointment of several Commissions by the Government, and to many reports by the Medical Officials of the Local Government Board.

As a result, it is a necessary part of the treatment of this disease to attend closely to the sanitation and to see that it is efficient; to see that the food of the infant, or indeed, of the mother or wet nurse is not contaminated by telluric emanations from being kept in underground cellars, or by emanations from accumulations of domestic refuse and filth, which enter pantries in which milk and other foods are stored. Close stores unexposed to currents of fresh air engender in such foods the properties which, when swallowed, set up the incipient stage of Diarrhoea, so often the fore-runner of a Choleraic outbreak.

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A thorough removal of refuse and filth at regular periods, a prevention of further accumulations, the inspection of sinks and drains, the washing out of closets at least once a week and the disinfection of all discharges from the bowel and of the clothes are essential points in reducing the mortality of this disease. The water supply should be stringently cared for, cisterns cleaned and the water examined for the presence of Nitrates, for although Infants do not drink water, it is used for diluting their milk and cleansing the utensils, and on that account demands the most careful attention. The water should be carefully examined for organic germs, both culturally and morphologically.

There is strong probability that the milk is the medium by which the specific poison enters the system, and the most exacting care should be devoted to it. It should be scrupulously boiled in spite of the loss of nutritive properties which boiling entails. Full directions should be given to mothers or nurses on this point. Trousseau points out that even mother's milk is liable to contamination. He says the "quality of the milk generally depends on its quantity. The milk of a woaman may be perfectly good for a particular child and exceedingly bad for another. Certain circumstances may/

may modify the quality of good milk and I must remind you that there are a few exceptional infants who cannot tolerate any kind of milk, woman's, cow's, goat's, or asses'." It is worth while also bearing in mind a further statement of Trousseau. "It has been alleged that lactation favours recovery from intercurrent diseases. I do think that convalescence is shortened by the mammary secretion establishing a sort of depurative action of a very energetic kind." Here then are two prophylactic indications, the general hygiene of the suckling mother is of the first importance; the regularity of food and diet, and the avoidance of anything likely to determine the absorption of deleterious material. Careful attention to any food idiosyncrasy on the part of the child is imperative and in the case of infants artificially fed, the brands of food should be most carefully supervised. The milk should be sterilized by boiling, and any signs of acidity, fermentation or dyspeptic troubles instantly attended to. The acidity of fermentation should be neutralised, and if possible in the case of a suckling mother , the services of a wet nurse should be obtained. Despite of following these general principles the cases go on to develop an obstinate diarrhoea .

It is of high importance to give early attention to these cases, and during the hot season to

banish/

banish from the mind all thoughts of teething, ileo-colitis or other common form of infant ailments, and to treat the symptoms as of serious import from the beginning. In the case of Infantile Diarrhoea, it is not merely catarrh nor inflammation, but a poisoning of the cardiac muscle and of the Nerve centres that are going to bring about the condition of exhaustion from which the patient is in such imminent danger of succumbing.

The prophylactic action of serums upon other specific febrile disease has no doubt led to the examination of this principle in connection with such an acute type of disease as Infantile Cholera. Some experiments which I have made in Germany during the summer of 1890 tend to show that at all events, it is possible to bring about a very considerable degree of immunity. I conducted a series of experiments on Guinea Pigs by injecting the blood serum from one Guinea Pig to another. At a certain stage a greatly modified virus was produced. Thus in a series of animals, numbered 1 severally up to 9, a gradual modification was noticeable as the innoculations became distant from the first. Thus in the case of the first, 5 minims of blood serum taken from a case of Infantile Cholera was injected round the shoulder joint of the animal

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and the virulence was such that in four hours the animal was manifestly ill and in 12 hours had violent manifestations and died in about 30 hours with all the pathological symptoms of Infantile Cholera. From the serum of this animal, Number 2 was injected, and this one died in 75 hours. From this, Number 3 was injected and died in 70 hours in great pain and with convulsions. From Number 3 the serum was obtained to inject Number 4, which lived four days. Number 5 pig died on the seventh day. From this, Number 6 was injected and lived up to the 14th day. From this, Number 7 was injected and lived, and so on with Numbers 8 and 9, neither of which animals died from the disease. Milk taken from the mother of a child who had died from Infantile Cholera was injected into a guinea pig which was not immune, and the animal died of a fatal diarrhoea, whereas in the case of an animal which had been subjected to the serum, modified by passing through several animals, the injected milk had no effect in producing the disease. Haffkine got the same reactions by passing a pure virus of Asiatic Cholera of known strength through a series of Guinea Pigs (See the British Medical Journal, February 11th, 1893),* and thus increased the virulence. He had to prepare a mild/

* I saw these experiments and reported them.

mild vaccin in artificial media and by injecting hypodermically, it was found that the mild virus protected the animal against the strong virus. The value of the method has not been fully proved, but it is sufficiently encouraging to justify its use. The same may be said of the serum of Infantile Cholera. The antitoxin has not yet been found, but it is in this direction that success is most likely to be met with in treating this disorder.

With this, as with other food diseases, the removal of the patient from the focal centre of the outbreak seems frequently even in advanced cases to cut short the course of Infantile Diarrhoea. This is especially the case for instance in Beri-beri, a disease with which no organism has been associated, but in which the symptoms of peripheral neuritis, due to bad food, are so prominent. The poison is taken into the body from without and is not formed in the economy. By removing the patient from the place in which the poison, whatever it may be, has been obtained, a cure will be effected. The last thing to think of in such cases is the drug. In many cases it has been shown to be the same/

same with Infantile Cholera. Locality has apparently great influence on Infantile Diarrhoea, for example, a high exposure with a hard water supply containing an abundance of lime salts seems to favour it. Thus in one case which came under my notice, (69 Moran Street) a child was brought in by its mother from North Wales to Clydach Vale, and there developed violent Infantile Diarrhoea. As soon as the child left this district for Wrexham, this passed off and the infant began to thrive well.

When the diagnosis is made it is useless to attempt in this disease to give milk. This diet must be stopped at once in all its forms. The only aliment permitted is distilled water or a little Vichy water administered with a teaspoon - at least for the first 24 hours.

Osler recommends in dieting that a wet nurse be obtained. In such a case we have certainly a change of venue as regards the diet; the main question is whether such a change of bringing the child to a fresh nurse is analagous to taking the child out of the district to the nurse. The general view is to avoid feeding these cases except under very special circumstances, with a special diet and under a strict regimen. The usual diet is entirely/

entirely suspended until the symptoms have abated. Some authors suggest the use of Ass's milk, but the vast majority incline to stop milk entirely and to administer plain distilled water.

Everything goes to shew that no specific treatment is available to destroy the germs of this disease. Certain lines of treatment have been formulated, based on the etiology and the nature of the symptoms. In treating the condition the eliminative treatment is recommended by many good authorities, thus following the indication of nature. The stomach is washed out with a long Catheter with an alkaline solution. Demme recommends a 2 or 2½% solution of Boracic Acid and Meinert is strong also on water infections. *

There can be no harm in this process and Cheedle recommends it to be followed by one or two grains of Calomel, which tends to check the fermentation. It is said that the poison on the other hand being of a proteid nature, may be precipitated by tannic acid or tannogen. Some recommend Tannic Acid Grs. II. and Glycerine every two hours to be given in the case of quite a small baby. In this way, the albumenoids are said to be neutralised. Nearly all authorities agree in giving/

* Verhandlung d 4, Congresses fur innere Medecin.

giving Castor Oil in cases of Infantile Diarrhoea. The following is a suitable formula:-

R Ol Ricini ..... MV

Mucilage of Tragacanth or Acacia ..... M.X.

Glycerin ..... M.III

Aqua Anethi ..... 1 dram

(Misce.)

Sg: To be given every two hours.

A combination of Rhubarb and Grey powder seems to have some beneficial effect on the intestinal tract. The following formula has been suggested:-

R Tr. Rhei ..... M.X.

Syr. Zingiberis .....

Glycerin .....

Mucilage of Tragacanth ... aa M.V.

It is Dr Goodhart who treats cases of febrile Diarrhoea with a dose of castor oil as above, followed by a simple alkaline mixture or by demulcents like Almond Oil, sweetened by Glycerine and made into an emulsion with Tragacanth. He gives this formula:-

R Pot. Bicarb ..... 1 dram

Oil of Sweet Almonds ..... ½ ounce.

Glycerini ..... 11 drams.

Compound powder of Tragacanth .... ½ dram.

Caraway water to ..... 2 ounces

SG: One dram to be given every four hours.

He adds, occasionally a few drops of Vinum Ipecacuhana. One of the oldest forms of eliminative treatment consisted of doses of Tartar emetic and Ipecacuahana to provoke emesis. Trosseau gave Ipecacuahana, - 30 to 40 grains in 24 hours in two or three doses. Sydenham washed out the stomach by promoting emesis by large draughts of milk and beer or black wine. Now, however, the same result can be brought about without unduly depressing the patient by washing with a fountain syringe, allowing one or two pints of water to flow into the stomach. One dram of Borax to the pint of water serves to remove fermenting substances and to cleanse the mucosa.

Others lay great stress on the sedative treatment and give soothing agents. Sydenham used a white mixture which may be taken as a type of the more modern medicaments:-

Calcined Hartshorn, Grammes 8

Bread Crumb ..... Do., ...24

Gum Arabic ..... Do., ... 8

Simple Syrup ..... Do., ... 60

Cinnamon water .... Do., ... 8

More/

More reliance is placed by modern practitioners on Castor Oil and Bismuth, which has a very sedative action on the bowel. A favourite formula recommended by Cheedle is:-

Carbonate of Bismuth .....
Castor Oil .....

The whole question of intestinal antiseptics is at present in a very unreliable state. Naphtalin, salol, Resorcin, Salacine, and Mercury have been tried with but varying degrees of success. Bismuth in large doses is often very effective, as much as two drams in the day for an infant a year old, in Cholera Infantum. Cheedle sometimes gives it with Opium, as in this formula:-

Bismuth Nitrate ..... 5 grains
Liq. Opii seditivus ..... ½ min.
Vin. Ipecacuhana ..... 3 min.
Aq. Cinamomi ..... 2 drams.

Bismuth with Dovers powder or chalk and soda is also recommended.

With this neutralising treatment, one has to mention the powerful effect produced by small doses of Liquor Hydrarg Perchloridi in certain forms of Diarrhoea. It is spoken of as a specific in Hill Diarrhoea so common in certain parts of India.

Dr/

Dr Duncan, a lecturer at the Tropical School of Medicine (London), avers that the Liquor Hydrarg. Perchloridi 1 dram, 15 minutes after food, three times a day, will cure Hill Diarrhoea within ten days. In cases of Infantile Cholera which suddenly develope very acute symptoms, this treatment (5 to 10 or less minims in Tragacanth) is deserving of careful trial and may at all events replace the Calomel and the Grey Powder treatment by way of experiment. I see it has been recommended by Cheedle and others in small doses of 2 minims given in the Castor Oil mixture alluded to above. This is said to have a wonderful effect in altering the headache and intestinal secretion and enabling the bowel to resist the formation of the absorption of the poison.

These are the general principles to which must be added a consideration of the action of Opium in these cases. This is a very vexed question and one which requires the greatest care. The condition of the Kidneys would certainly warrant one in withholding the drug, and indeed most authorities are agreed that it has no effect whatever in checking the Diarrhoea of Infantile Cholera. It is used, however, in small doses where there is much restlessness, although many authorities prefer/

fer the use of Chloral and the Bromides under such circumstances. On the other hand, laudanum was constantly used by the older physicians. Holt recommends the hypodermic injection of Morphine and Atropine in exceedingly minute doses as a cardiac stimulant - Morphine 1/100th grain, and Atropine 1/800ths Grain, to be injected hypodermically. It is probably best to adopt Trosseau's recommendation in this disease, to <u>avoid Opium rigorously in every form</u>. He says it too readily leads to the typhic stage. Henoch puts it in this way, "It follows that the practice of giving Opium at once, which only serves to keep the injurious matter longer in the intestinal canal, is unsuitable in this disease" ..... "Should the attack continue in spite of treatment, or should the patient only come under the treatment after the disease has lasted some days, I then no longer avoid the use of Opium, for we may safely assume that the infectious germs have been got rid of, so we have not now to dread their retention. In such cases I add 5 to 15 drops of the Tincture of Opium to the Hydrochloric mixture and also give twice or thrice daily a Starch enema containing 1½ to 3 drops of laudanum. His formula is as follows:-

Acid/

Acid Hydrochlor. dil., ... 20 to 40 minims.
Tinct Opii, ... 3 to 6 minims.
Mucilaginis, ... ½ dram.
Aquam ad, ... 4 ounces.
Sg: A dessertspoonful every 2 hours."

Perhaps it would be as well to give with greater precision the views that are held by authorities in our own hospitals for children on this point. Dr Nestor Tirard in his work, "Medical Treatment", says: "It is often recommended that Opium, in some form, should be administered in severe cases; and elaborate calculations have been made to show that the amount of Opium present in the compound kino powder, or in the aromatic chalk and opium powder, is so small that it is possible, and even desirable to employ this remedy, trusting to the kino and aromatic chalk powder to exert a beneficial astringent action, which is to be aided by the sedative influence of the Opium. I have rarely employed Opium in this way for infants, nor do I think that it is a safe remedy to use when the child is already suffering from extreme weakness and collapse. These conditions appear to result far more from the system than from pain, and it is therefore hazardous to employ a drug which entails further risk."

After/

After clearing out the irritating substances or removing the bacteria, the bowel may remain irritated and in order to soothe this, Chalk, Bismuth and Opium administered either by the mouth or rectum are used according to the state of the Diarrhoea. Besides these, various astringent medicines have been used although as a rule astringents are not of so much importance in the treatment of Infantile Diarrhoea. Haematoxylin may be used as a basis and is a useful astringent. It colours stools and cloths red. The vegetable astringents employed contain tannin in various forms, more especially Rhatany, Krameria, Kino, Catechu, and some others. They can be used in the form of infusions, decoctions, tinctures or extracts.

Sometimes it is useful to employ the inorganic astringents such as Sulphate of Copper or Zinc, or Nitrate of Silver, of which Trosseau recommends one Centigramme in 60 to 100 grammes of water (distilled). This is a sedative to the stomach and tends to prevent Diarrhoea as well. Another powerful Drug much used in the treatment of this disease is pale French Brandy - a diffusable stimulant. It is either administered in bread jelly food with peptonised milk one or two spoonfuls an hour, or in/

in Brand's Essence, or Valentine's Meat Juice: the dose of brandy varies from 5 to 10 minims up to 30 or 60 according to the age of the child. It arrests fermentation and is an excellent sedative for children. It should be given before the collapse stage comes on, and if it is vomited it should be given by the rectum. Brandy and ice in champagne in very small doses are usually tolerated if given by the mouth, especially after the cessation of the vomiting.

This is a condition which calls for prompt attention in the way of baths for young infants. Trousseau says: "I look upon the mustard bath as a powerful medication in Infantile Cholera when the disease is in the first stage." He employed it in the following manner:- 50 grammes of mustard is enclosed in a little bag and used to sinapise about 25 litres of water; the water should be cold, as hot water prevents the extraction of the essential oil of the mustard. The bath is used for 12 to 15 minutes. Reaction comes slowly. The child ought to be wrapped up in blankets or very dry linens. The child should not be kept longer in the mustard bath than for the nurse to feel her arms smarting slightly. Under this treatment, the cutaneous surface becomes exceedingly red and presents the appearance of goose skin.

The directions given by Goodhart for the warm mustard bath are to put a tablespoonful of mustard to the gallon of water; then wrap in blankets and surround with hot bottles. If the temperature is high (over 105-108) a tepid bath with a temperature of 85° - 90° F. ~~degrees~~ should be frequently employed and this should be repeated for three or four hours if necessary, although it is a very severe measure for babies.

In treating the exhaustion which follows the rapid wasting, it is necessary to bear in mind that it arises from two causes:- The want of rest and food and the loss of fixed albumens. This is seen by the tremendous amount of wasting that takes place in the subcutaneous tissues and the muscles. If possible, this has to be combatted by the use of diffusible stimulant - Brandy (already mentioned); Ether in the form of syrup, a teaspoonful every hour or half hour; Beef tea; Chicken soup - if the condition of the stomach will permit; - Bread-jelly food; Peptonised milk (the milk should not be over peptonised as that is apt to cause further diarrhoea); Brand's Essence; Valentine's Meat Juice should be employed, especially if the sickness has ceased for 24 hours. If collapse is imminent, Beef Jelly or Beef Tea enemas should be used./

used. When the temperature has reached an excessive stage, baths should be given every 10 or 30 minutes. Iced water in each case with the rectal tube should be administered. At the same time, when collapse is imminent, the external temperature is to be maintained by hot baths, hot bottles, and hot bags. It is exceedingly important in a disease where the nutrition is so greatly impaired and the loss of substance so great, to make up for the loss of nutrition by maintaining the external temperature. It is very marked in conditions like Sprue, where the continued low diet tends to exhaust the patient. He can be kept on a minimum milk diet for 6 weeks or 2 months, provided the temperature is kept high and the patient's external temperature is not allowed to fall low. The suddenness of the attack and the exhaustion of the sufferer sometimes make it somewhat difficult to utilize this means in the case of Infantile Diarrhoea. One of the methods which has been handed down for combatting the loss of fluids and the great thirst of the sufferer in this disease, is Trousseau's Egg Albumen diluted with water, the famous Eau Albumineuse of Trousseau, provided - as Osler points out - the stools are not foul. If there is established sour, but not foetid stools, the Albumin diet is given:- all broths, such as those/

those mentioned above, or the Egg Albumen, which Trousseau directs to be made in the following manner:- "Dilute the white of four eggs with a litre of water and sweeten to the taste by adding orange-flower water." This is an excellent remedy and greatly appreciated.

In order to maintain the amount of fluids in the body, it has been suggested that an injection of the normal saline solution should be made in the loose cellular tissue of the abdomen. It should be administered with an ordinary antitoxin syringe subcutaneously. Two ounces may be injected on each side of the abdomen; the temperature should be 100 to 102; sometimes brandy should be added to this injection. As, however, this leaves a bruised mark on the abdomen, the practitioner should be careful to inform the parents of this. The formula has been used as follows:-

Muriate of Soda ..... 3 grs.)
Desquicarb. of Soda .. 4 scruples) (Water 10 pts.

If the child lives through this, the diet upon which it is most likely to thrive subsequently is also an old one laid down by Trousseau. This is known as "the raw meat" treatment. When it is found that milk preparations disagree with the child/

the child it is suggested that it should abstain from them, and should live on nothing but Barley water for two or three days. At the end of this time, a return may have to be made from the farinaceous food to a proteid diet, and it should be given nothing but Raw Beef Juice or White of Egg and water for a day or two more, and then at the end of this time the child may be able to take milk again.

Trousseau's method of making this beef preparation is as follows:- "Take a piece of Beef, Mutton or Fowl - Beef and Mutton are preferable - cut it up into very small morsels, then put it into a mortar, and with a pestle work into a thick mass. The pulp so made is then passed through a cullender so fine as to permit nothing to be used except the juice of the meat, and the fibrine of the blood, leaving behind blood vessels and clear cellular tissue. By this means, a puree de viande, which is collected by scraping the external surface of the cullender, or for the puree de viande may be substituted - meat chopped as small as possible, for this can be easily digested, though with less facility than the puree. Children seem to like it." Sometimes it is made up into balls with salt and sugar and with the jelly or conserve of Rose's/

Rose's or put into clear gravy soup, or with a little tapioca, or sago, or mixed with chocolate and water. Small quantities are administered at first, in about the weight of a sixpenny piece or a gramme, gradually increased up to 25 grams, three or four times a day. With this diet the drink should be - in the circumstances already related - the Eau Albumineuse. It modifies the Diarrhoea, and the children like it. The head symptoms are assuaged by ice-cold cloths or the ice-cap applied to the head.

Convalescence is sometimes slow and tonic treatment has to be administered such as nux vomica and iron, - perchloride, or the hypo-phosphates.